



GeoSLAM Construction Progress

Software Guide

Instructions for software configuration and operation



Notes

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Notation



Information that supplements or clarifies text.



A caution that actions, operation or configuration may lead to incorrect or improper use of the hardware/software.



A warning that actions, operation, or configuration may result in regulatory noncompliance, safety issues or equipment damage.

Italics

Italics are used for unique terminology and part numbers, and for emphasis.

Options_> Data

This notation is used for user interface controls and navigation.

/data/dd_mm_yy_xxx

This font is used for file and directory names, terminal interface input/output, and output in the text section of the main user interface window.

Scope

GeoSLAM Construction Progress is a tool to monitor the development of building projects using automated workflows. Our GeoSLAM hardware solutions make capturing data easy and fast, and now GeoSLAM Construction Progress enables rapid downstream processing and deliverable creation, with the ability to share data easily and cut costs.

GeoSLAM Connect is the platform from which we are creating modules such as GeoSLAM Construction Progress to simplify and automate traditionally manual processes. As we expand this software package, users will be able to create innovative and customisable workflows.

The software contains 2 main components – GeoSLAM Viewer and Connect Control Centre. GeoSLAM Connect Viewer is designed to be user friendly and requires minimal input from the customer, whereas in Control Centre more commands and workflows can be explored. Initially, customers should only need to use the Viewer component of Connect, and simply import a .geoslam file along with a pre-written workflow script to output floorplans. With further updates and modules, GeoSLAM Connect Control Centre will be utilised.

Error! Reference source not found. of this guide covers installation and licensing of the software package. *Reference Topics* including the Program Interface provided in Error! Reference source not found. **and** *How-To Topics* are provided in Error! Reference source not found.. Background information concerning the concepts used in the software are provided in **Error! Reference source not found.**

Further help and information

In the event of a problem that cannot be resolved using the information supplied, please contact GeoSLAM. You can also gain assistance through the support page on our website: <https://geoslam.com/support/>

For further assistance, contact the GeoSLAM Technical Support by telephone or email. Our Customer Support personnel will discuss your situation, determine the cause of the problem and provide the appropriate technical assistance.

Contact GeoSLAM by any of the following methods:

- Phone: +44 (0) 1157 270740 (all countries)
- Phone: +1-833-444-7907 (US & Canada)
- Email: support@geoslam.com

Part 2 - Software Installation

GeoSLAM Connect is comprised of two components; GeoSLAM Connect Viewer and Connect Control Centre. To process data, use automatic workflows and visualize outputs you will need to use Connect Viewer.

Software required

Software Package	Current Version
GeoSLAM Note APK	V2
GeoSLAM Connect Viewer	Beta 40
GeoSLAM Connect Control Center	Beta 40
GeoSLAM Licence Manager	1.0.1
GeoSLAM Hub	6.1.0

Table 1 – Software required.



GeoSLAM FloorPlans is protected using Flexera software-based copy protection and licensing. A single licence key is provided with each copy unless further seats or licenses are purchased. The licence key can either be activated directly via the internet or using a manual activation for offline computers.

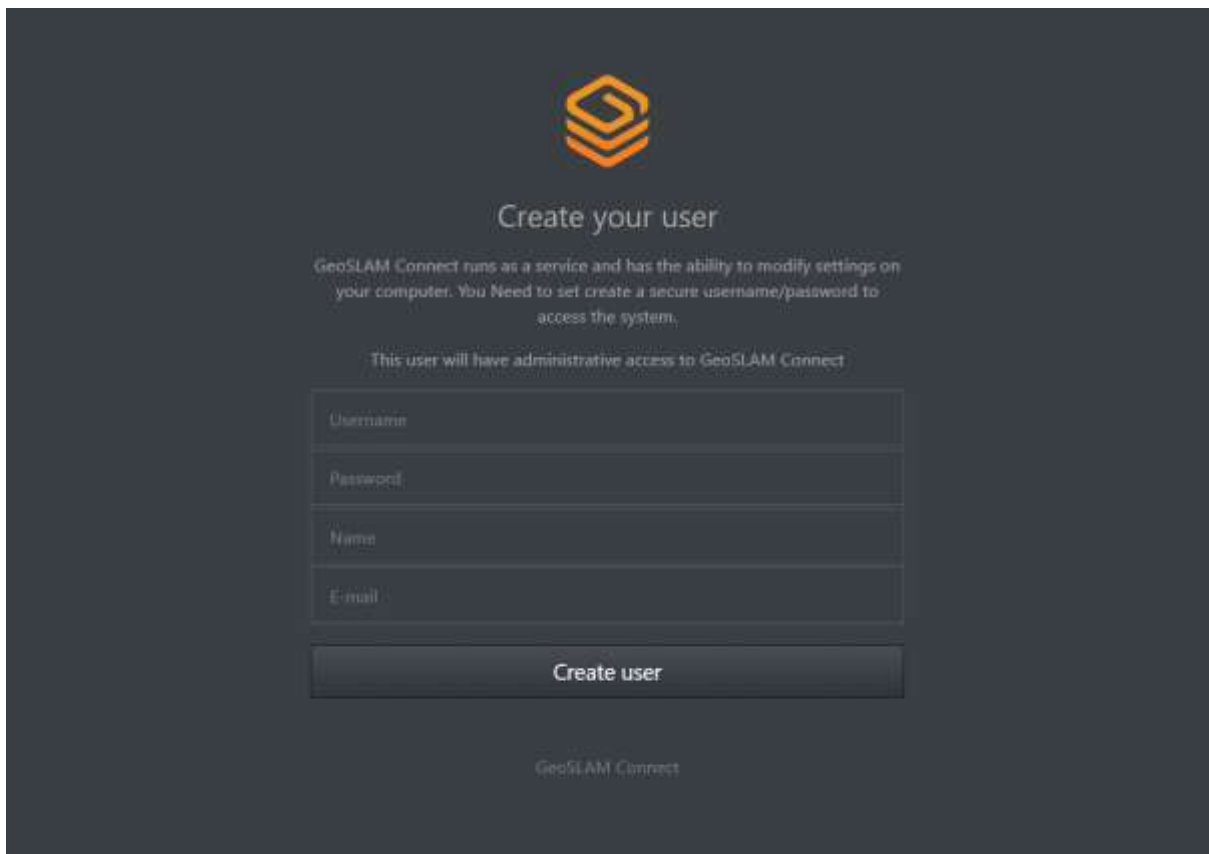
Once the application installer has been selected and the default settings accepted, the option to create a Super Administrator will be available (**Error! Reference source not found.**). These credentials are currently saved to the local machine so cannot be transferred from one PC to another. These login details will be the same for the GeoSLAM Connect Viewer and the Control Centre software.

System requirements

System Requirements	
Minimum	Recommended
Windows 10	Windows 10
i7 6th Generation	i7, i9 8th generation or greater (higher clock speed)
AMD Ryzen 7 (1700X)	AMD Ryzen 7 (2700X)
Integrated Graphics	NVIDIA GTX 1060
16GB RAM	32GB RAM
30GB free space	30GB free space
SSD	SSD

Table 2 – System requirements.

Software installation and configuration



GeoSLAM Connect runs as a service and has the ability to modify settings on your computer. You Need to set create a secure username/password to access the system.

This user will have administrative access to GeoSLAM Connect

Username

Password

Name

E-mail

Create user

GeoSLAM Connect

Figure 1 – Super Administrator creation.

After installation, the user will be able to open Connect via either the Desktop shortcut, or from the search bar (**Error! Reference source not found.**).

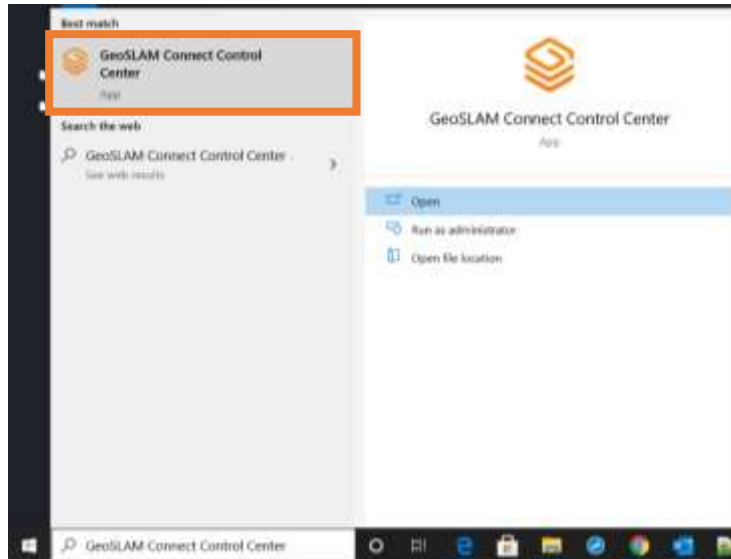


Figure 2 - Connect Control Centre.

Adding Geoscripts

Geoscripts are the scripted workflows that have been designed to automate processing and simplify tasks for the user.

The Geoscripts required to perform Construction Progress tasks are provided with the software and will need to be copied to the location *C:\ProgramData\LidarOs\geoscripts*. Any future Geoscripts will need to be copied to this location and can then be selected from the Connect Viewer interface when importing data.



Figure 3 - Location of Geoscripts.

Data folder structure

The data outputs and project folders will be created within the LidarOs folder structure located in *C:\ProgramData\LidarOs*.

License activation

To activate a licence, make sure to install GeoSLAM's License Manager Tool (**Error! Reference source not found.**). A GeoSLAM Connect Licence can be activated either online, or for environments without an internet connection – offline (a user requires two PCs, one with an internet connection for offline activation).

A 32-character **Activation ID** is required to licence Connect features.

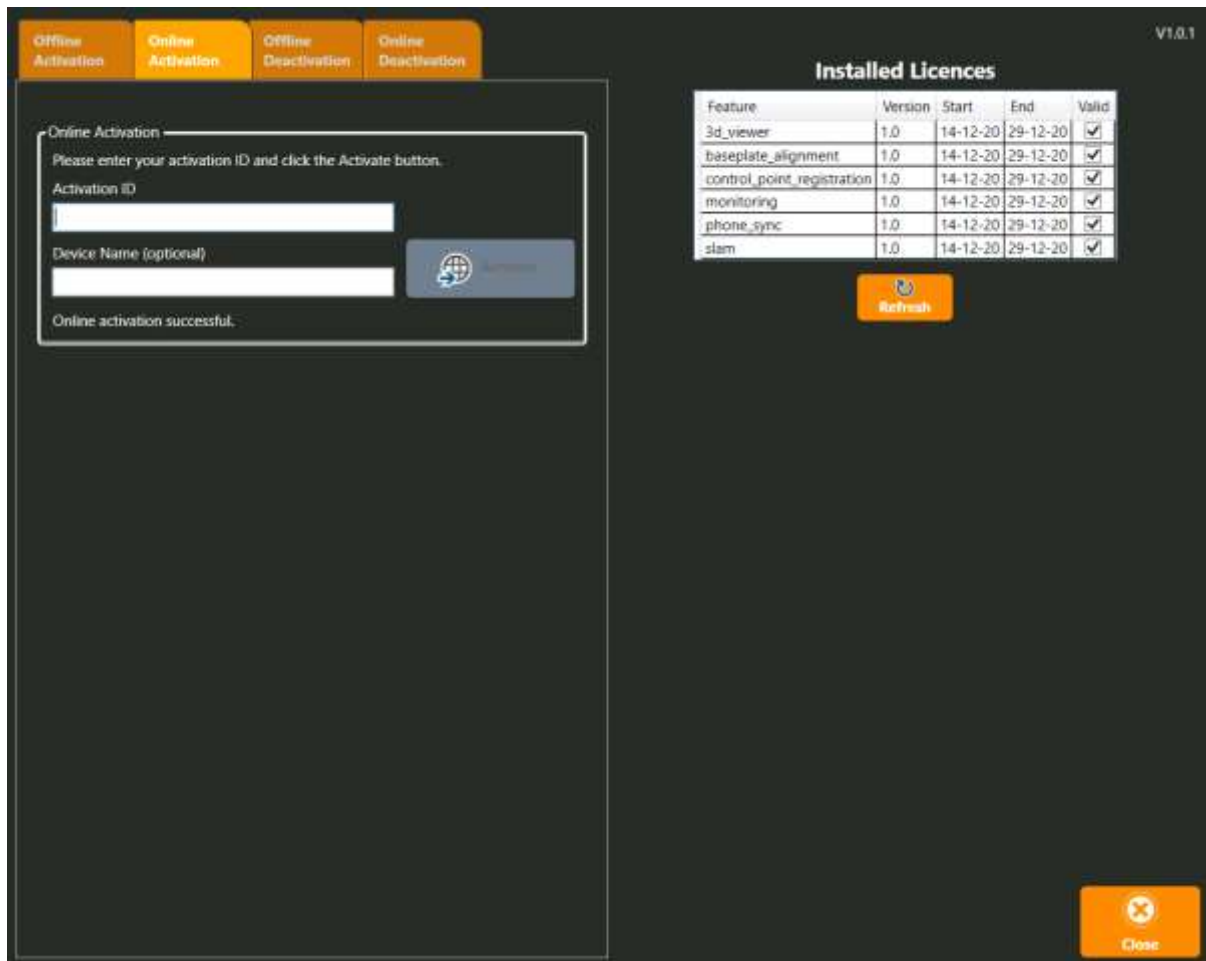


Figure 4 - GeoSLAM Licence Manager main window.

When opened, the program will determine if a valid software license is available and display all active licences on the right-hand side of the main window. The feature, version and start and end dates are available to view at any time, giving the user the ability to check if their licence's validity. The table can be refreshed at any time, allowing the user to confirm licence activation.

Online Activation

This process is only applicable for PCs with an internet connection. This connection can be a temporary connection in order to communicate with the licensing database. Once, the software is activated the software does not need to maintain this connection and the internet connection can be disabled.

To complete the Online Activation

1. *Select* -> **Online Activation** tab (Figure 3).
2. *Input* -> **Activation ID** -> the activation code provided with the system.
3. The **Device Name** field can be left *Blank*.
4. *Select* -> **Activate**, to begin the activation process.

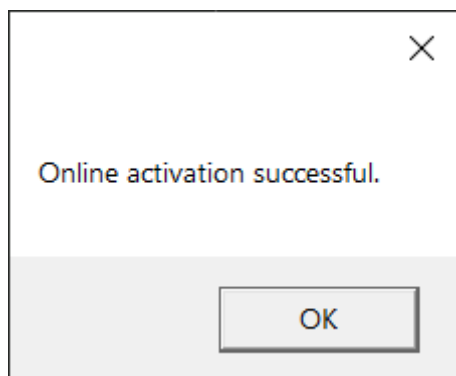


Figure 5 - Activation successful message will pop up after entering legitimate Activation ID

Offline Activation

In order to undertake an offline activation, the user must have access to both the PC running the *Connect* software and a second PC that must have an internet connection.

To activate the license, the user must create a *Capability Request* file. This file must be then manually transferred from the *offline* PC to an internet enabled PC, which then will create a *Capability Response* using a web-based portal. The *Capability Response* file must then be transferred back from the internet enabled PC to the *offline* PC.

1. *Select* -> **Offline Activation** tab (**Error! Reference source not found.**).
2. *Input* -> **Activation ID** -> the activation code provided with the system.
3. The **Device Name** field can be left *Blank*.
4. *Select* -> **Create File**, to create the *Capability Request* file. This will open the Create License Activation Request File dialog (Figure).
5. *Browse* -> save location.
6. *Select* -> **Save**, to continue.
7. The process will create 2 files (). The *Capability Request* file plus a text file containing a link to the Flexera Network Operations (FNO) website.
8. Manually, copy the *Capability Request* file from the offline PC to the PC with internet connection.

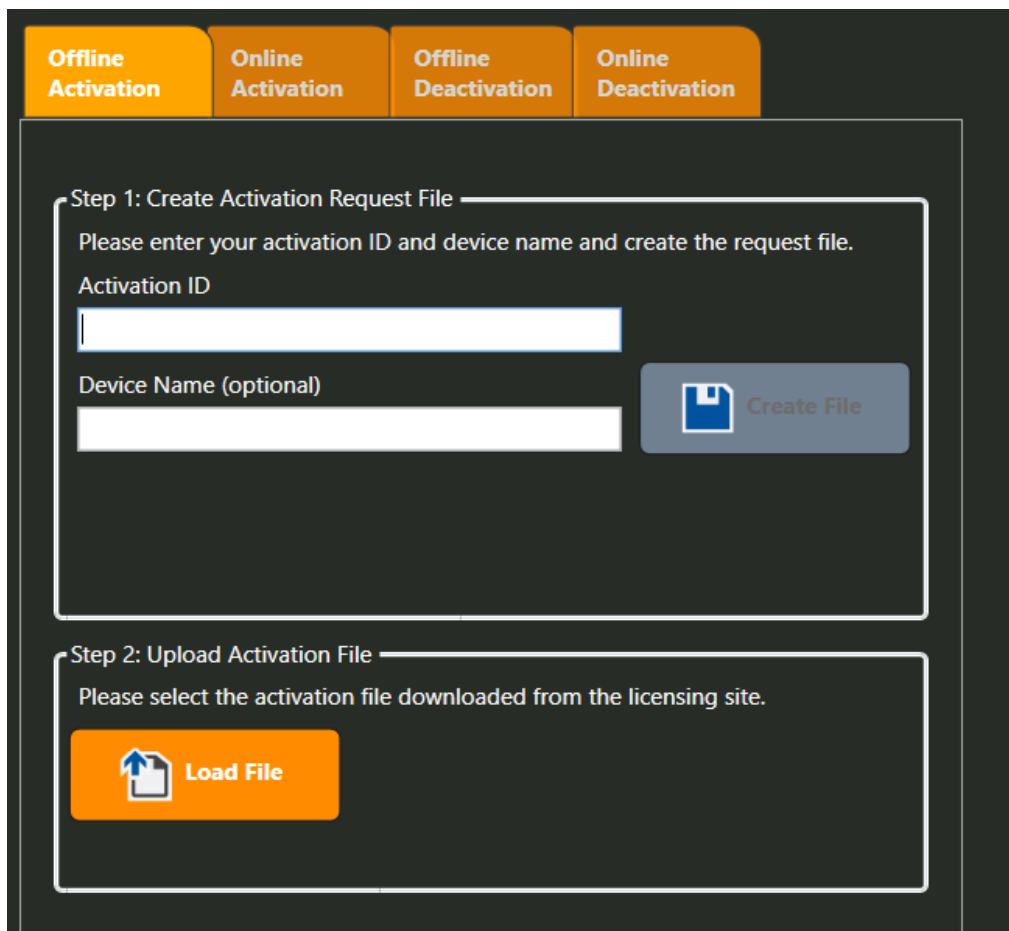


Figure 6 - Offline activation tab within GeoSLAM Licence Manager Tool.

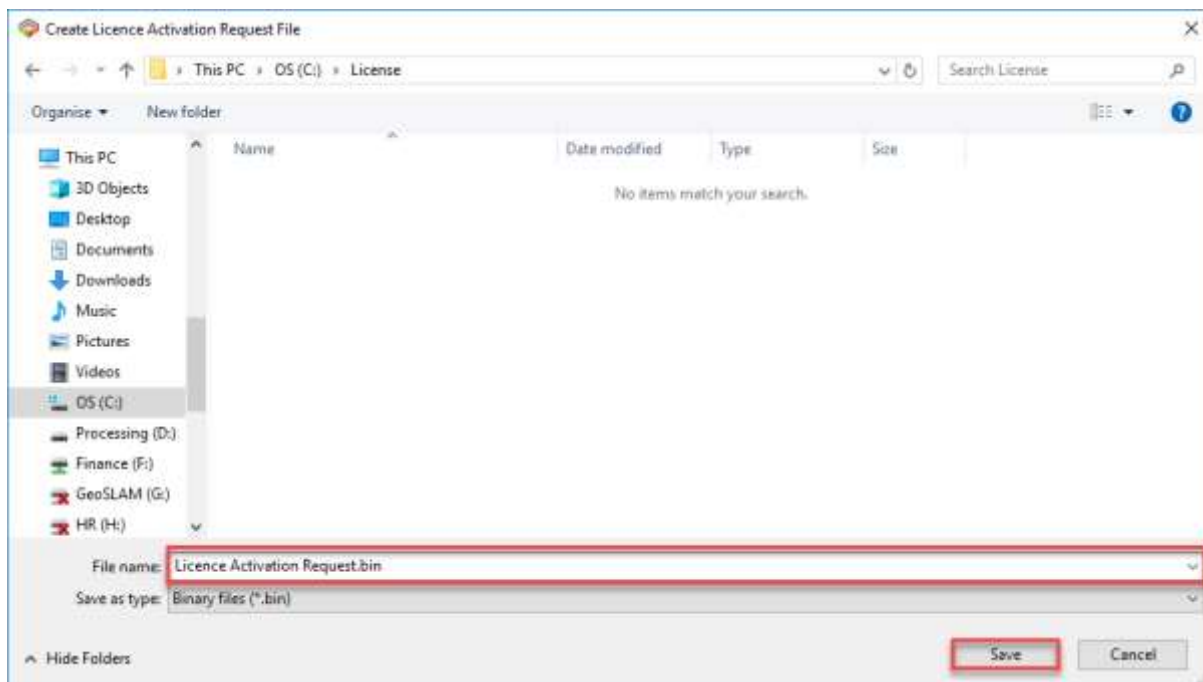


Figure 7 - Creating a Licence Activation Request.bin file.

9. From an internet enabled computer, open an internet browser.
10. Copy and paste the *FNO* login screen address from the text file to display the log in dialog (**Error! Reference source not found.**).
11. At the log-in screen, *Select* -> **Activation ID**.
12. *Input* -> **Activation ID**, provided with the system.
13. *Select* -> Log in, to continue.

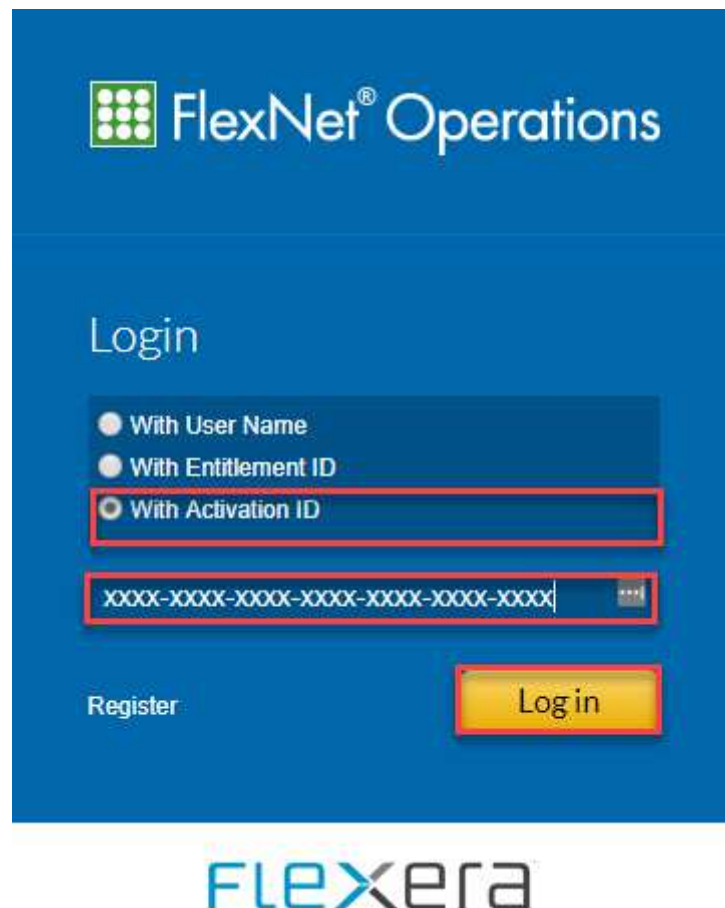


Figure 8 - FlexNet Operations screen, select login with Activation ID, and enter your 32 character licence as shown

14. If the log in process is successful, this will open the License and Delivery Portal (**Error! Reference source not found.**).
15. *Select* -> **Devices** -> **Offline Device Management** (**Error! Reference source not found.**).
16. This will open the **Offline Data Management** screen (**Error! Reference source not found.**).
 - a. *Select* -> Generate License.
 - b. *Select* -> **Choose File** and browse to the location of the *Capability Request* file.
 - c. *Select* -> **Upload** to continue.
17. The system will offer the user the ability to download a *Capability Response* file.

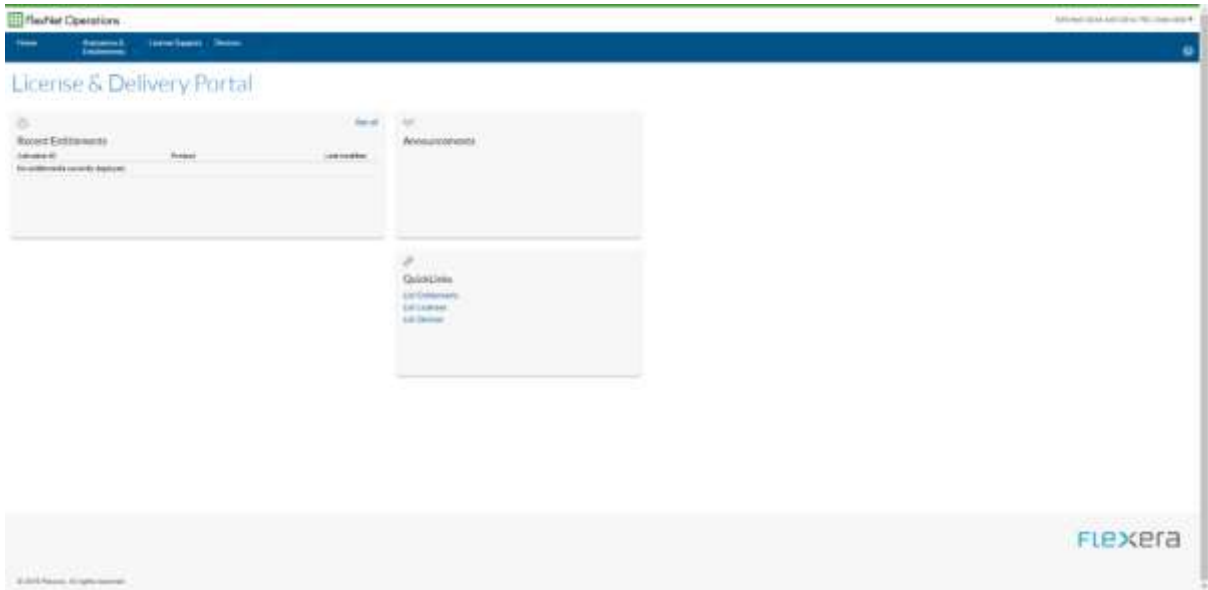


Figure 9 - License and Delivery Portal.

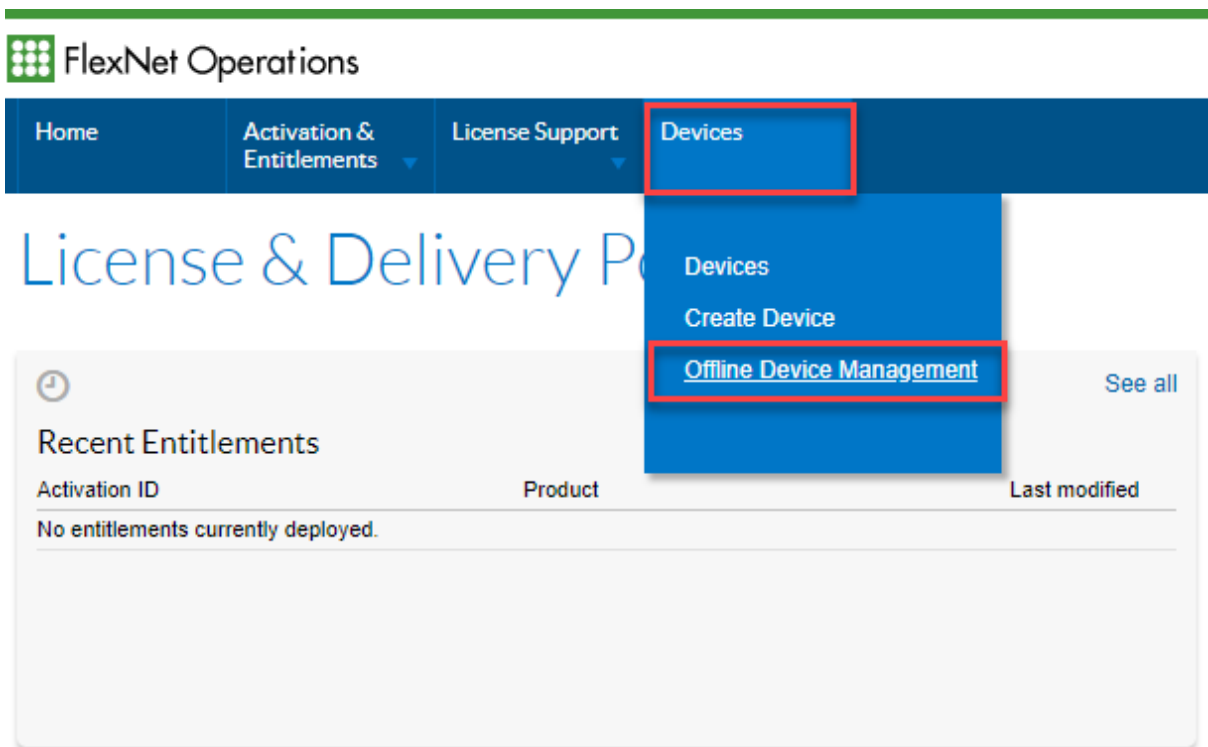


Figure 10 - Select the Offline Device Management Option.

Offline Device Management

Manually upload either a Capability Request or Synchronization History Files for offline processing. The application will offer you a response file to download.

Upload type: Generate license
 Upload synchronization history

Licence Acti... Request.bin

Figure 11 - Offline Device Management.

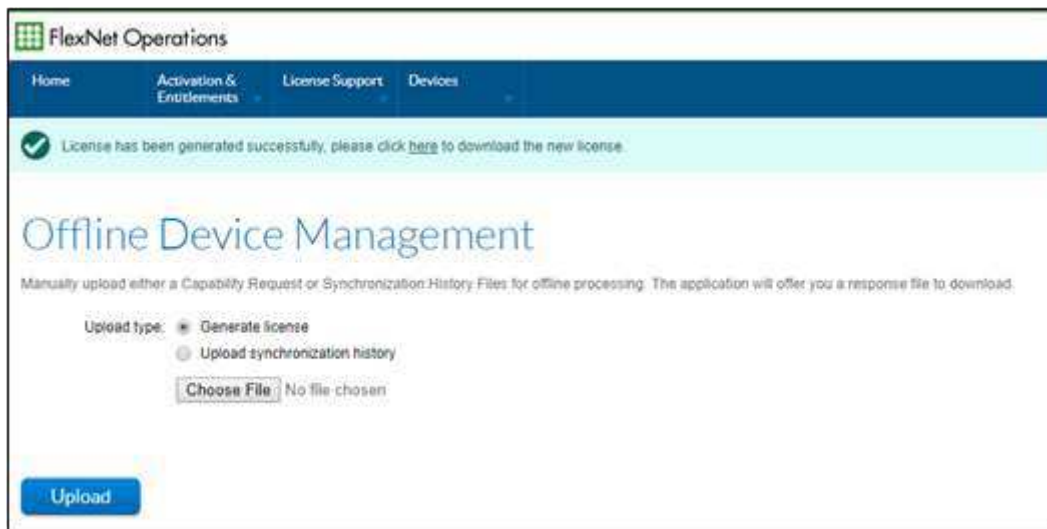


Figure 12 - The FNO Offline Device Management screen, with a link for downloading the “Capability Response” file.

18. Manually copy the *Capability Response* file back to the offline PC and return to the Offline Activation dialog.
19. Step 2 -> Select -> **Load File** and browse to the location of the *Capability Response* file.
20. Select -> *Open* to continue.
21. The software should now be activated and open to the start screen.

Part 3 – Program Interface

Connect Control Centre

The Connect Control Center is part of the software which is installed with the GeoSLAM PointCloud Viewer. The Control Center allows for a more advanced customizable experience and many commands are available using the terminal. For GeoSLAM Construction Progress, it is not necessary to use Control Center, as the workflows are defined and processed solely in the GeoSLAM Connect Viewer software. This section provides a brief summary of the GeoSLAM Connect Control Center.

File formats

GeoSLAM Connect is designed to work exclusively with GeoSLAM products. However, can be exported to several common point cloud data formats.

Data Type	Format	Format type
Input data format	GeoSLAM, GeoSLAM Zip*	GeoSLAM Binary
Input control file format	Reference points obtained from GEOSLAM file	X,Y,Z
Output format	LAS, LAZ, PLY	Binary

Table 3 - File formats used by GeoSLAM Connect.

* GeoSLAM Zip files produced by ZEB Revo/ Go scanners

Program Window

Opening the application after setup will first display the log in screen requiring the user details created during setup. The main window is divided into 3 sections:

1. Various Connect commands explained in detail in Figure 14.
2. User and System options.
3. Connect condition (i.e. connected to WiFi, database and the Connect service).

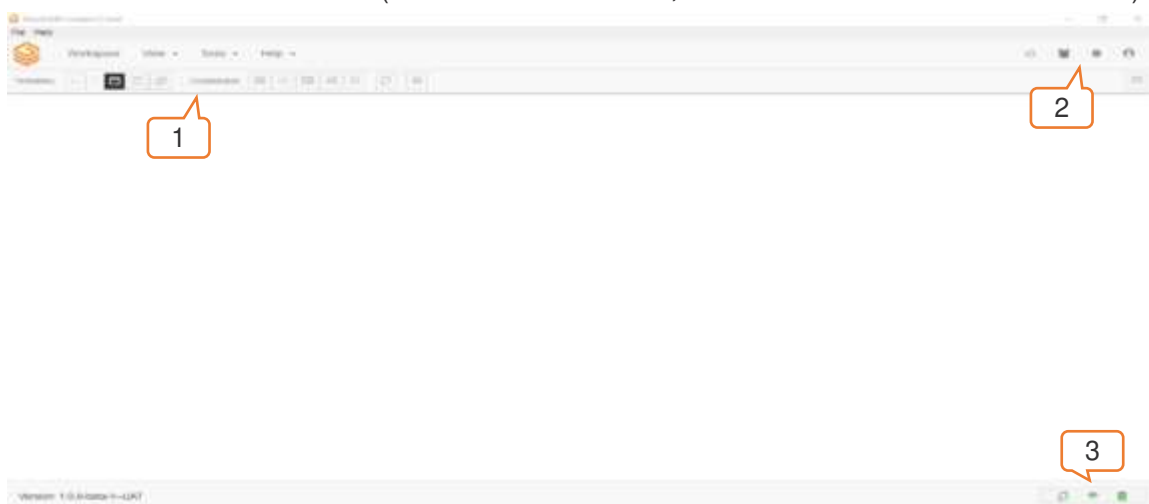


Figure 13 – Main Connect window.

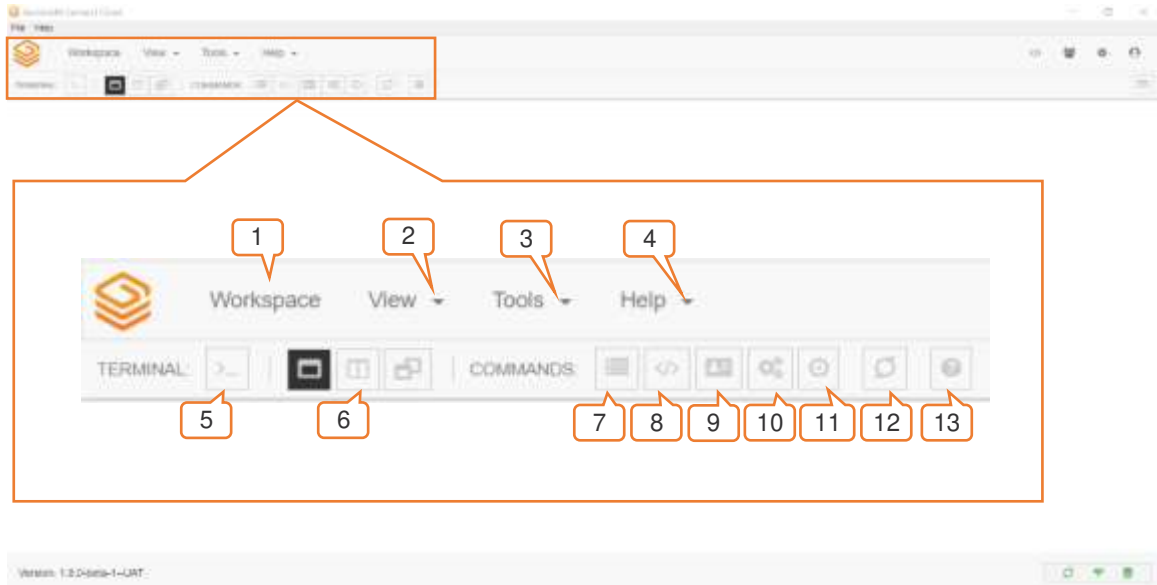


Figure 14 – A close-up of the main window.

Number	Item	Description
1	Workspace icon	Acts as the Home button
2	View Dropdown Menu	Contains a log of all commands run via connect, including file watchers. Outputs can be filtered to search for specific commands or error messages for support.
3	Tools Dropdown Menu	Currently the Script editor is the only available tool. More can be added as the release progresses.
4	Help Dropdown Menu	Provides some basic information regarding Connect and the version installed.
5	Terminal	Icon that links to main Connect terminal. More than one terminal can be connected at any one time.
6	Terminal Window Size	Three icons that allow for the terminal to be resized to fit the users preference.
7	List Datasets Window	Not currently usable.
8	List Scripts Window	Lists all scripts currently available in Geoscripts directory. These scripts can be called from the terminal.
9	List OS Version Window	Details which version of Connect is currently installed
10	Get Server Memory window	Details current usable memory available
11	List file watchers window	Lists all file watchers currently active
12	Add new Server location	Currently not used.
13	Command List Help	Searchable database of all commands currently available within Connect. Similar output to that received when running the help command from the terminal.

Table 4 – Connect features.

Connect Terminal

The Connect Terminal is the main method for exploring the service and its commands. The terminal can run single commands or workflows which have been written as a Geoscript (linking many commands together).

Opening a new terminal session

To open the terminal:

1. *Open* -> *GeoSLAM Connect Control Center*.
2. *Sign in* -> Credentials are the same as GeoSLAM PointCloud Viewer.
3. *Select* -> **Add Terminal** icon.
 - a. *Select* -> **Servers**-> **LocalHost**

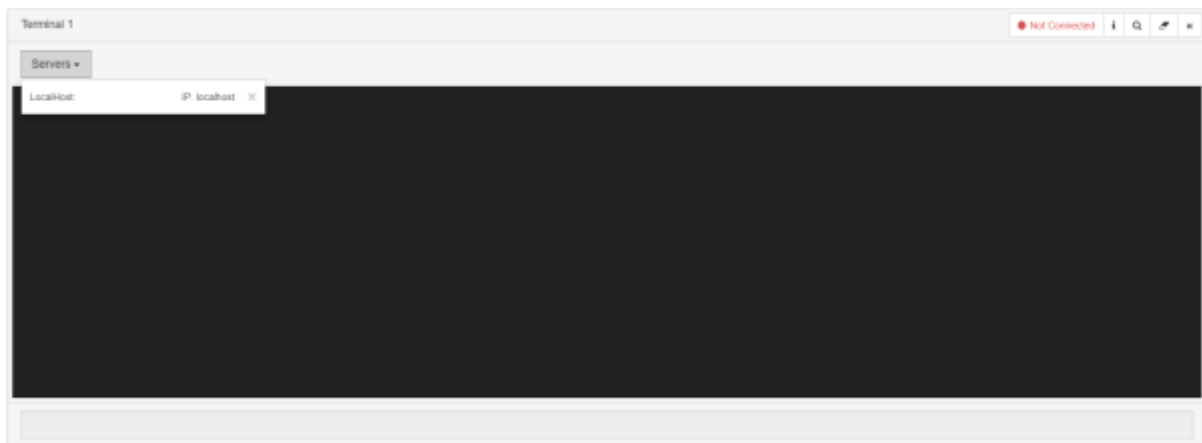


Figure 15 – The Connect main terminal, before connecting to the localhost server.

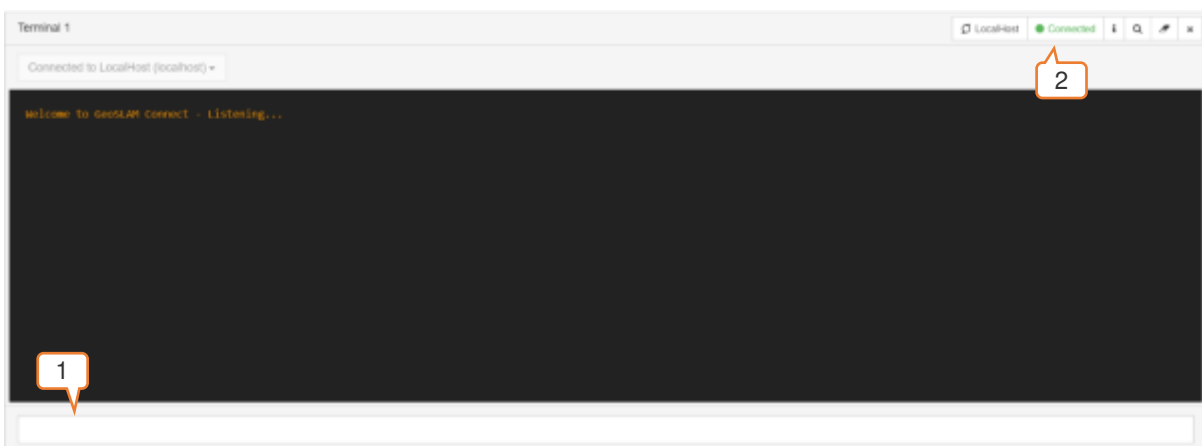



Figure 16 – The Connect main terminal, after connecting to the localhost server.

Once connected, the type bar will become active (1) and the terminal will confirm the connection (2). Type **help** into the type bar (1) in order to bring up a full list of all commands available in Connect; alternatively, see Table 4 (13) for the database of commands.

Command List

To access the list of commands:

1. *Select* -> **Command List Help** icon  .
2. *Search* -> desired command.

Or

3. *Select* -> **Category** from drop-down list.



Figure 17 - Selecting the command help icon.

Commands can be run directly from the terminal and using the Command Help List will give examples of using the command and required parameters needed for input. Related commands will be listed on the left-hand panel.

Navigation

Table 5 highlights some useful keyboard shortcuts applicable when using the terminal.

Description	Keyboard shortcut
Help/Settings	Ctrl + F2
Show Terminal	Shift + F1
Hide Terminal	Shift + F2
Run Current Script	F8

Table 5 - Keyboard shortcuts in the terminal

GeoSLAM Connect has a custom high-level scripting language – similar to, but more user-friendly than Bash. If users wish for more in-depth instructions regarding script creation, please contact GeoSLAM Support.

GeoSLAM Viewer interface

The GeoSLAM Connect Viewer is designed to simplify and automate tasks and allow visualization of the output from the background scripting process. The viewer is designed to be the primary software required to output multiple floorplans and reports, these workflows are explained in more detail in the **User Workflows** section of this document.

Sign in

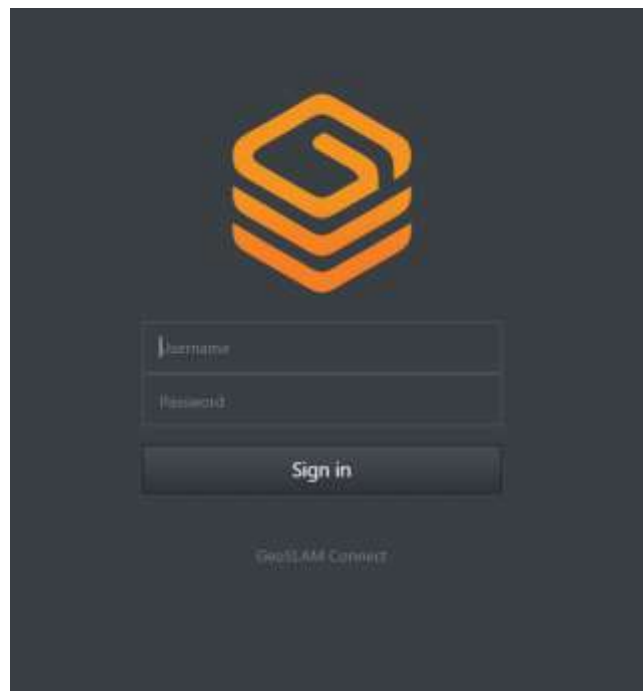



Figure 18 - Log in view for GeoSLAM PointCloud Viewer.

On startup, a prompt is displayed to insert the credentials defined during the installation of the software (Figure 18). These details are used for signing in to both the GeoSLAM Control Center and Geoslam Connect Viewer.

Logout

The  icon in the top-right corner allows the user to log out of the Connect Viewer.

File formats

GeoSLAM Connect is designed to work exclusively with GeoSLAM products and will process data captured with any of the ZEB family of scanners. LAZ files are supported in the GeoSLAM Connect Viewer and outputs from Geoscripts can be exported to several common point cloud data formats.

Data Type	Format	Format type
Input data format	GeoSLAM, GeoSLAM Zip*	GeoSLAM Binary
Input control file format	Reference points obtained from GEOSLAM file	X,Y,Z
Output format	LAS, LAZ, PLY	Binary

Table 6 - File formats used by GeoSLAM Connect.
* GeoSLAM Zip files produced by ZEB Revo/ Go scanners

Program window

The program window will open to display the main screen (Figure 19). The main window is divided into 2 sections:

1. Toolbar to create new projects and
2. Data visualization window

Main window layout

The toolbar to the left of the display screen contains the controls to create a new project and define the workflow. Once a project is active, all controls will be visible.

Main window with project loaded

Once a project is active, multiple options to view the data and add information to the project become available. Table 8 gives more information about these toolbars.

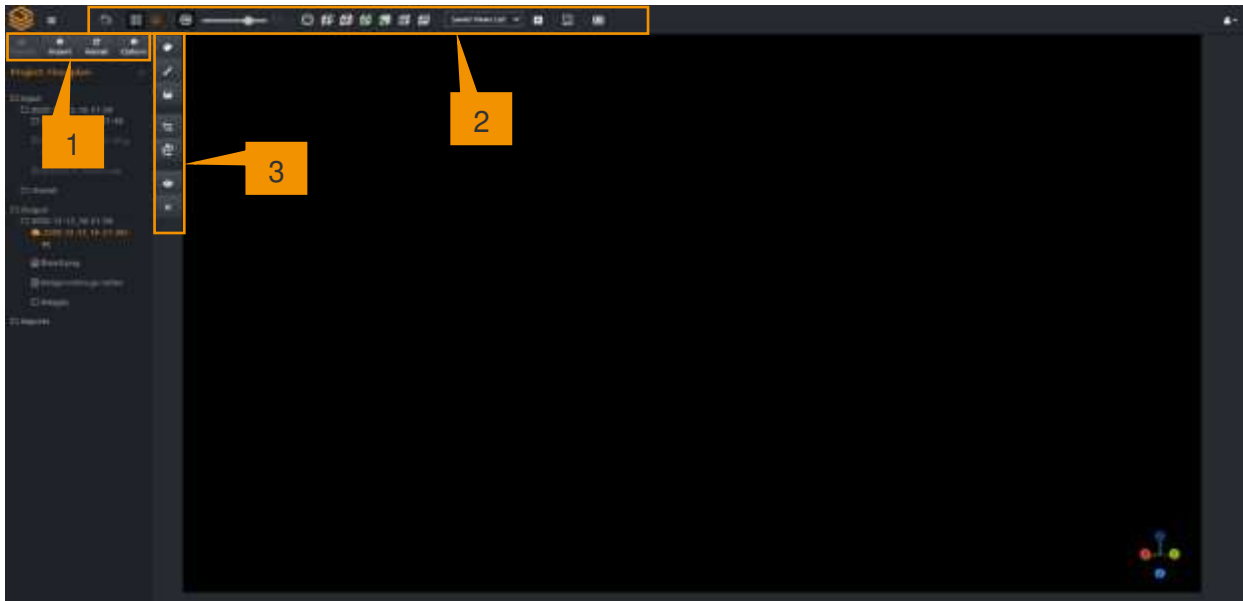


Figure 19 – Program window showing all active toolbars

Number	Description
1	Project options. This toolbar will become active when a project is loaded.
2	View settings. The PDF Report buttons will become active when a project is loaded.
3	Display options. This toolbar will become active when a LAZ file is displayed in the viewer.

Table 7 – Toolbar descriptions.

Panel 1 – File menu

Project Tree

The project tree is shown on the left-hand side of the viewer window when a project is active. This will show the input, output and any PDF reports created in that project.

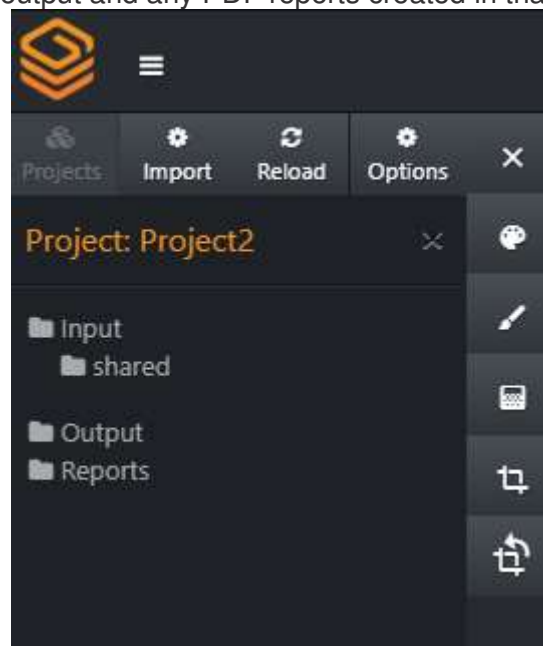


Figure 20 – Project tree.

When a project is loaded there are several options available:

1. Import data.
2. Reload/ refresh the project list.
3. Options – Allows the user to change the workflow of the project.

Create a new project

Using the Connect Viewer, each project is set up by defining the project name and a pre-defined workflow.

To create a new Floorplans project:

4. Open -> *Connect PointCloud Viewer*
5. Select ->  -> *Projects->Create New Project*
6. This will open the *Add New Project* dialog (Figure 22).
 - a. Input -> **Setup** ->
 - i. **Project Name.**
 - ii. **Define Workflow.**

The options within the *Add New Project* dialog are described in **Error! Reference source not found.9.**

Option	Description
Project name	The user must enter a name to define the project. The Project name must start with a letter and contain minimum 4 characters.
Workflow	A list of workflows will appear. Workflows must be saved into <i>C:\ProgramData\LidarOs\geoscripts</i> in order to appear here.

Table 8 - Create New Project input options

7. Select -> *Create Project*

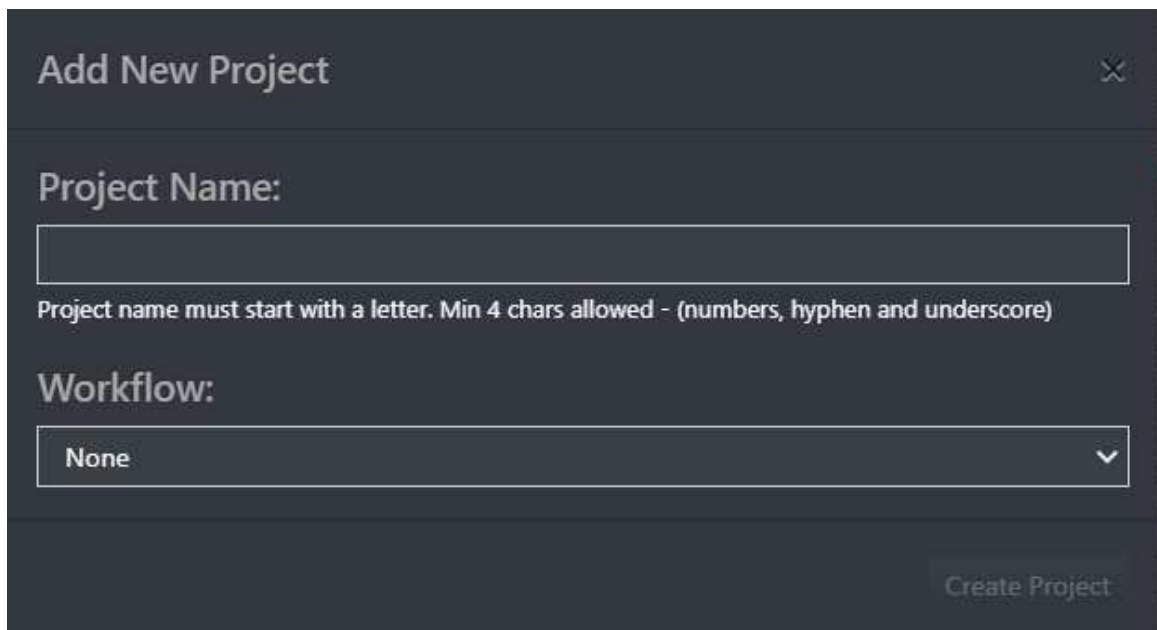



Figure 21 - Add New Project dialog box

The newly created project will be displayed in the project tree view on the left of the screen. Options to Import, Reload and Options will appear once the project is defined.

Open an existing project

Saved projects will appear as a list in the Project Menu.

To open an existing project:

1. *Open -> GeoSLAM PointCloud Viewer.*
2. *Select ->  -> **Projects.***
3. This will open the project list.
4. *Select -> required project by double clicking.*

Delete a project

Projects can be deleted from this view by clicking the **X** icon.

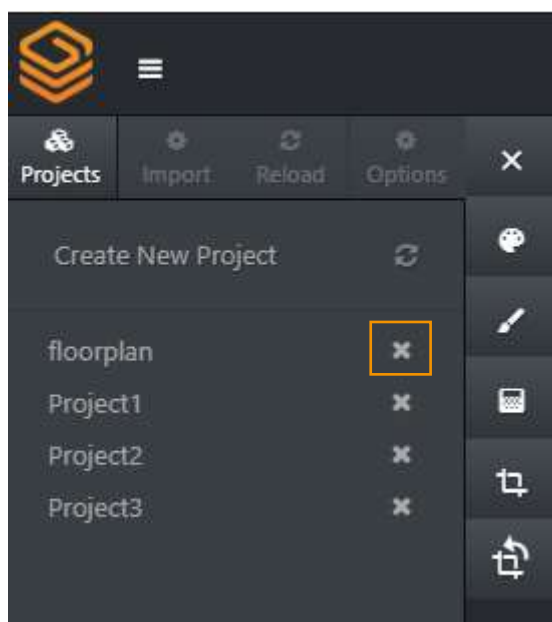


Figure 22 - Project list.



Only one instance of a project can be opened at the same time.



Please note when deleting a project from the project list, it will also be permanently deleted from the projects folder in C:\ProgramData\LidarOs\projects.

Importing data

To import data into the project:

1. *Select* -> **Import** icon.
2. From the *Open* dialog, browse to the data folder containing the data to import.
3. *Select* -> *user defined file(s)*.
4. More than one file can be selected at this stage e.g., scan data and zipped GeoSLAM Note data.
5. *Select* -> **Import**.
6. This will close the dialog box.

A progress bar will appear at the top of the Project Tree indicating how many datasets have been imported. This will show the progress of the whole workflow, and the processing time will be determined by the size and length of the scan imported.

Advanced import settings

The Advanced Import section gives more information on the different import options:

1. Run Input workflow **Once with all files**
2. Run Input workflow **several times, once for each file.**

For the Floorplans workflow, **Run Input workflow Once with all files** should be selected.

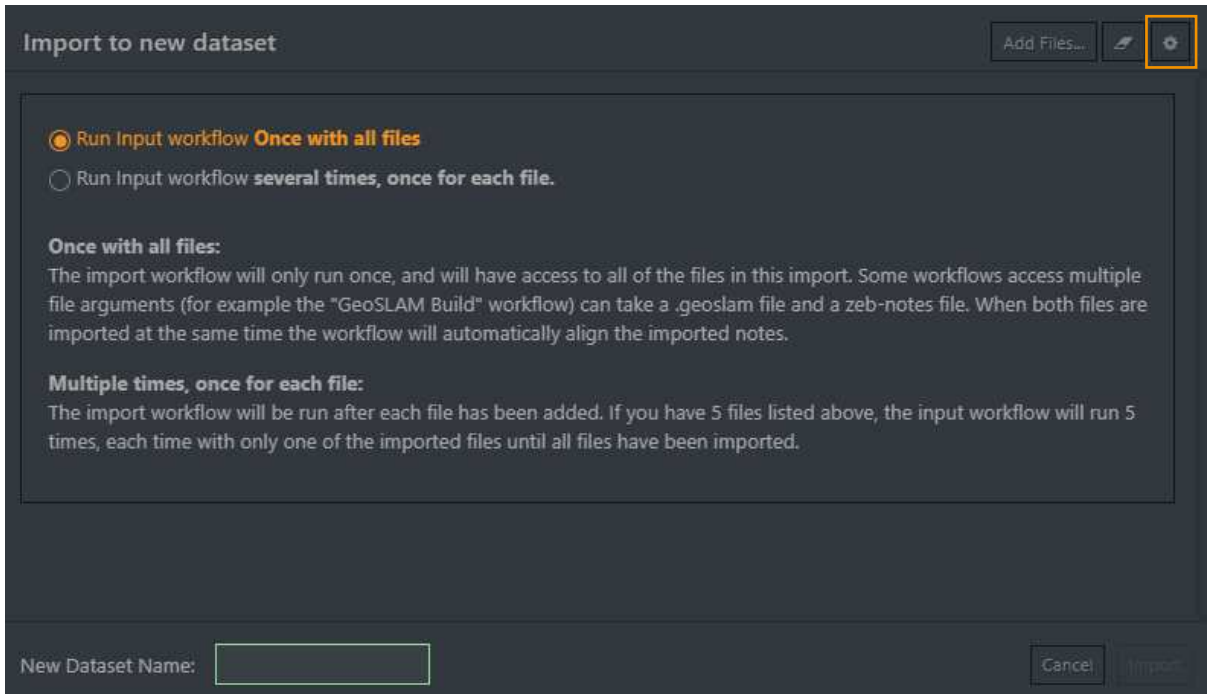


Figure 23 – Import data dialog box.

Reload

The reload button will refresh the active project list to display any changes. Once a workflow has completed the project list will be refreshed automatically and the output data displayed on the Project Tree.

Options

To change the current workflow for the project:

1. *Select* -> **Options**.
2. *Select* -> Workflow from drop-down list.
3. *Select* -> **Close**.


Notification will show that the project workflow has been changed.

Panel 2 – Point colour and clipping

Displaying data in the viewer

Once a workflow has completed, the LAZ file will appear in the output folder in the Project Tree.

To view the different output files:

1. Double click on the LAZ file to open in in the viewer window.
2. Floorplan PNG images will open in a new window.
3. Images and notes will appear as icons in the viewer. Double click on the icon in the viewer to open the picture/note.
4. Use the  button to toggle the layers visibility.


Use the  button to close the layer.



Figure 24 - An example of opening the image from the viewer.

Navigation

The camera orbits a target and is always orientated towards that point. The pitch of the view can be changed however the roll is fixed. When a dataset is opened, the camera will switch to the default view which shows the project from above. These views can be quickly changed using the view settings on the top toolbar.

You can use keyboard shortcuts or the mouse to navigate in the Connect Viewer, these are explained in Table 10.


Function	Keyboard shortcut	Mouse
Navigation Mode		
Reset View	T	 Clicking 'Reset View' icon
Rotate	Q,E	Hold down the left mouse button and dragging will rotate the scan
Zoom In	N/A	Mouse Wheel Fwd.
Zoom Out	N/A	Mouse Wheel Rev.
Pan	W,A,S,D	Holding down the right button and dragging will translate the scan position in space.

Table 9 – Navigation options.

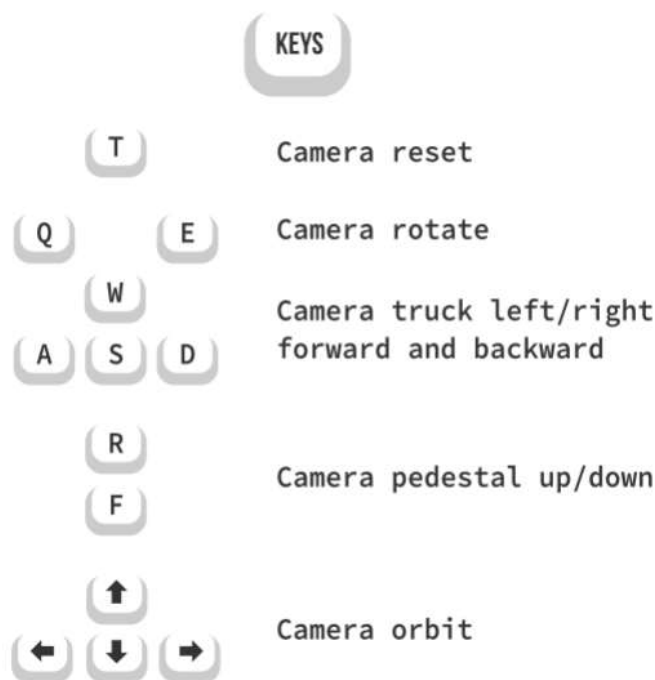


Figure 25 – Navigation using keyboard shortcuts.

Set colour mode

When a LAZ file is loaded in the viewer, the Display Options toolbar is active and allows the user to change the colour mode and point colour.

The LAZ file can be coloured by:

1. Elevation.
2. Solid (single colour).
3. Intensity (for ZEB Horizon data only).
4. RGB.
5. Time.
6. Pre-defined colour maps.

The pointcloud layer visibility can be switched on/off using the **Toggle Visibility** button





The pointcloud layer can be closed using the **Close** button



Clipping box

When a LAZ file is loaded in the viewer, the Display Options toolbar is active and allows the user to clip the pointcloud to an area of interest. Stray points and any points which extend the bounds beyond the area of interest can be clipped using 6 axis-aligned clipping planes.

To clip the pointcloud:

1. *Select* -> **Enable Clipping** icon .
2. Click -> select which plane to clip.
3. Drag -> arrow to desired position.
4. Press -> Escape key to end clipping.
5. *Click* on the Reset Clipping icon to undo any changes .

Save views

Customisable views of the display window can be saved to review for future reference or to include in a PDF report. The current clipping and camera position will be saved.

To save a view:

1. *Select*-> **Add New View** icon.
2. *Input* -> View name.
3. *Select* -> **Save View**.

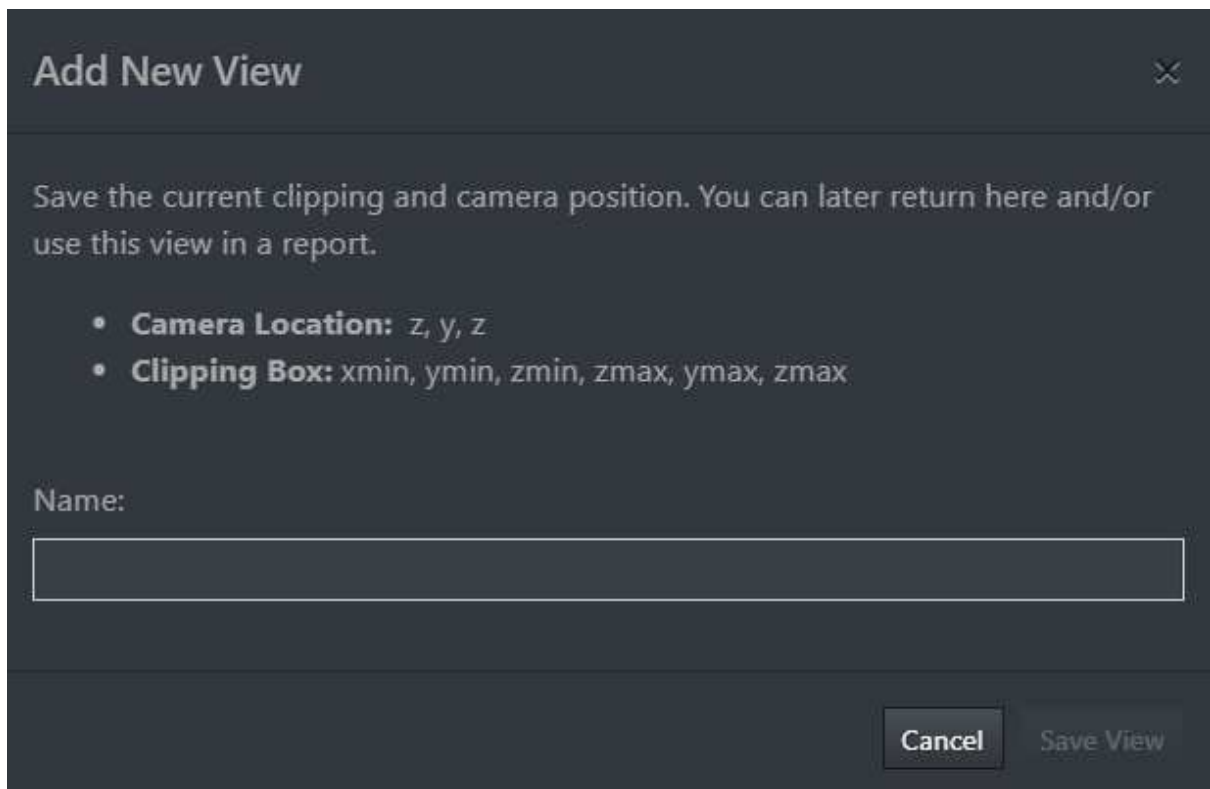


Figure 26 - Add New View dialog box.

Panel 3 - View modes and reporting

Display Options Toolbar


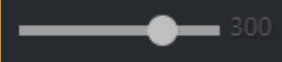








Icon	Function	Description
	Set Background Colour	Change the display background to a solid colour.
	Toggle Grid	Switch the reference grid on/off.
	Toggle reference Cube	Switch the reference cube on/off.
	Eye Dome Lighting	Switch shading to improve depth perception on/off.
	Eye Dome Lighting Value	Change the value of EDL filter (recommended 50).
	Reset View	Camera position reverts back to the default.
	Left View	Switches camera view to target the left clipping axis.
	Right View	Switches camera view to target the right clipping axis.
	Front View	Switches camera view to target the front clipping axis.
	Back View	Switches camera view to target the back clipping axis.
	Top View	Switches camera view to target the top clipping axis.
	Bottom View	Switches camera view to target the bottom clipping axis.
	List of Saved Views	Drop-down list of all saved views.
	Add New View	Save the current clipping and camera position.
	Generate Report	Generate PDF report using saved views.
	Close All	Close all views.

Table 10 – Description of display toolbar options.

PDF reporting

Selecting the *Generate Report* icon will open a secondary *Create Report* Dialog (Figure 28).

Create Report [Close]

This will generate a simple PDF report containing the text below and a screenshot from the current 3D view.

The report will be saved to the Reports folder in this project

Name:

Figure 27 – Create report dialog box.

To create a report:

1. *Select* -> **Generate Report** icon.
2. This will open the *Generate Report* dialog.
3. *Input* -> Report name.
4. *Select* -> Saved views to include in the report.
5. *Input* -> Any project notes to be included.
6. *Select* -> Generate report

The report will be created and saved to *C:\ProgramData\LidarOs\projects\Floorplan\Reports*. The output will appear on the Project Tree list under **Reports**.

7. *Double click* -> on the newly generated report.

This will open the PDF report using the default web browser. The report will display the notes at the top of the PDF and selected saved views and their titles on separate pages.

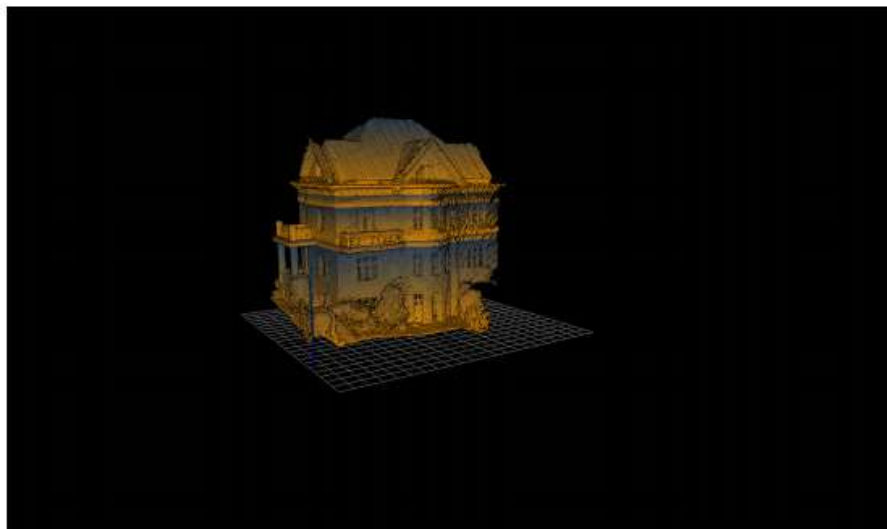
Once a report has been created, it cannot currently be edited. There is no limit to the number of reports than can be created per project, each report will appear in the project tree list under **Reports** and saved in *C:\ProgramData\LidarOs\projects\Floorplan\Reports*.

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Figure 28 – PDF report example.

GeoSLAM Note APK

This section will describe how to set up and use the GeoSLAM Note to capture images and/or notes for use in the scan project.

Including images as reference into the 3D scan can add an extra level of detail to the project. Images can easily be captured whilst scanning, with a section to add notes to give extra context to the image. The GeoSLAM Note APK is included within the GeoSLAM Connect bundle and is currently only compatible with Android phones.

Setup

The GeoSLAM Note APK must be downloaded onto an Android phone running Android 8.0 or above. The app will create an icon on the device menu screen and will also create a data folder within the Files app -> Internal Storage -> GeoSLAM Note. Select the GeoSLAM Note app from the menu screen to begin collecting images/notes.

The Android device should be mounted to the phone mount shipped with the GeoSLAM scanner prior to collecting any data. This ensures the camera trajectory and scanner trajectory are optimised to sync easily within the data processing workflow. The Phone app can be started at any time, please refer to the User Guide of the GeoSLAM scanner for setup instructions.

Interface

The app has four function buttons:

1. Start recording icon.
2. Stop recording icon.
3. Capture image icon.
4. Save image/note icon.

GeoSLAM uses the device camera to capture the image and contains a note section to make annotations during the scan (Figure 29).

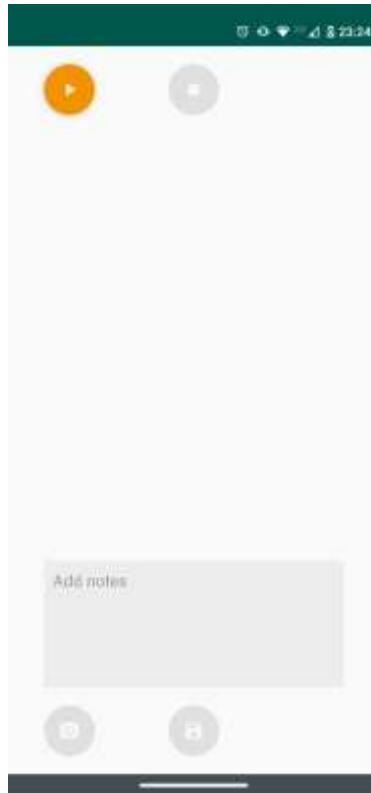


Figure 29 – GeoSLAM Note interface

Data capture

Ensure there is some movement before the first image is taken to allow the software to recognise when there is a static period during image capture (minimum 5 meters between starting the scan and capturing the first image).

When capturing an image or note, remain static for at least 5 seconds. This will allow the software to accurately match the trajectory of the scanner and images during image capture periods.

There is no limit to the number of images that can be captured, however it is recommended to capture a minimum of 2 images per project (if images are required).

To begin data capture:

1. *Select* -> Start recording icon.
2. *Select* -> Capture icon.
3. *Take photo*.
4. *Select* -> tick to confirm image is correct.
5. *Add notes* (Figure 30).
6. *Save after each image captured*.
7. *Select* -> Stop recording icon to complete the image capture.



Figure 30 – GeoSLAM Note adding notes to images.

Data download

Once the project has been stopped, the app will automatically zip the images and camera trajectory into one file. Once zipping has completed, a pop-up message will appear confirming the zip is complete. This file can be found in the GeoSLAM Note directory within the Files app -> Internal Storage -> GeoSLAM Note.

The data will be named automatically using the date and timestamp of the capture in the format `YYYYMMDD_HHMMSS`.



User workflows – Construction Progress

This section describes the workflow for tracking and monitoring the progress of construction projects. The Geoscript **3d-change-1.3.geoscript** has two output options depending on the scope of the project. The different uses for **3d-change-1.3.geoscript** are outlined below:

- Construction progress between scans
 - Creating a new project and comparing a reference scan with subsequent scans(s) to show construction progress.
 - OPTIONAL: Add images/text to give context
- Construction progress compared to the final CAD model
 - Creating a new project and comparing a reference scan with subsequent scans(s) to show construction progress THEN comparing to a CAD model.
- OPTIONAL: Add images/text to give context

Construction progress can be monitored over time by detecting the change between a reference scan and subsequent comparison scans. When a new scan is added to the project, a point cloud is created and coloured based on feature change:

- Green = New feature added since last scan
- Blue = Old feature removed since last scan
- Black = Not enough point density in original scan for classification
- Grey = No noticeable change

Construction progress can also be monitored by comparing the scan(s) to a CAD model. Using this option, a point cloud is created and coloured based on progress in comparison to the final CAD model:

- Green = New feature added since last scan
- Blue = Old feature removed since last scan
- Black = Not enough point density in original scan for classification
- Grey = No noticeable change

Photos and notes can be included to add an extra level of detail to a project when highlighting part of the scan that requires special attention. The images or notes added will show an arrow specifying which direction the area of interest is in relation to the image capture.

Project Setup

1. Copy the scanner data files from the system data logger using a *USB 3.0 Flash drive* following the instructions in the product hardware guide.
 - a. *Copy -> raw scanner data file -> USB flash drive.*
2. Copy the image data zip file from the Android device using a Micro USB cable to transfer data to the PC.
 - a. *Copy -> image data zip file -> Micro USB cable.*

Construction progress between scans

Creating a new project and comparing a reference scan with subsequent scans(s) to show construction progress.

This workflow describes the steps necessary when creating a new project and using the Geoscript **3d-change-1.3geoscript** to produce a point cloud which is coloured based on feature change between a reference scan and a comparison scan. This script will use the first scan imported as the reference scan, whilst all subsequent files will be considered the comparison scan. The script identifies reference points in each scan and uses these to register the comparison scan to the reference scan. Feature changes can then be identified and will be coloured to display the difference. These colours can be categorized as follows:

- Green = New feature added since last scan
- Blue = Old feature removed since last scan
- Black = Not enough point density in original scan for classification
- Grey = No noticeable change

During the data capture, a minimum of 3 reference points must be captured. This will allow the workflow to identify common points between scans and identify change. These points are captured when scanning, by placing any GeoSLAM scanner on a surface for a minimum of 10 seconds. Within all scans, these exact points must be recaptured exactly for registration to be successful.

The workflow will treat any initial imported GeoSLAM file as the dataset to which all other GeoSLAM files are registered to. Therefore, it is especially important for the initial scan to follow all best practices of scanning, and to note the exact location of any registered control points for future use (or with use of the reference base). Please see section 5 – **Technical Reference** for more detail on the best practice for scanning with Construction Progress in mind.

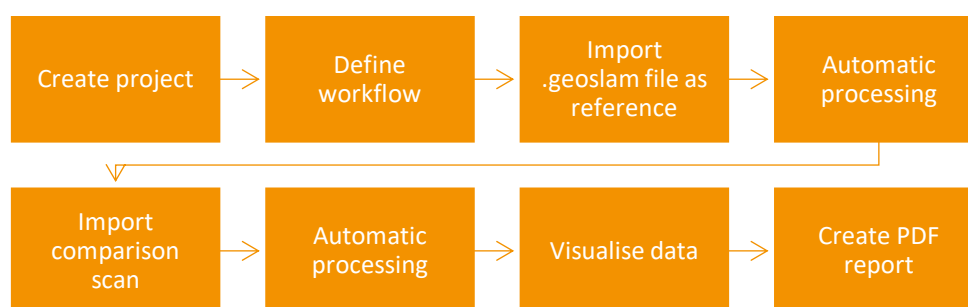


Figure 31 – Create reference project workflow.

Step 1 – Create New Project

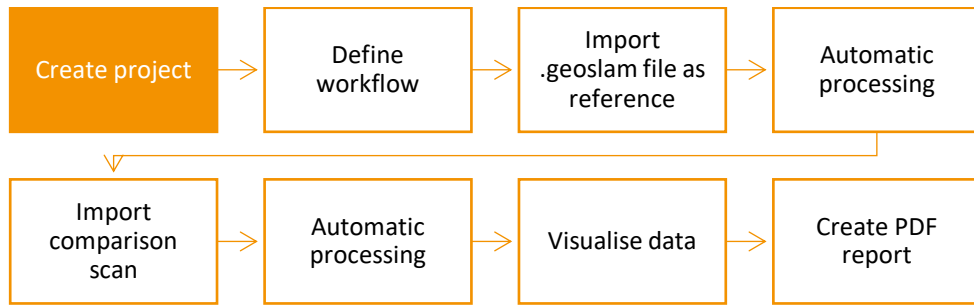



Figure 32 - Construction Progress workflow use: Step 1.

1. Open *GeoSLAM Connect Viewer* and sign in.
2. To create a new project, Select ->  -> **Projects** -> **Create New Project**.
 - a. At the *Add New Project* dialog:
 - i. Input -> **Project Name**.
 - ii. Input -> Workflow **3d-change-1.3.geoscript**.
 - b. Select -> **Create Project** to continue.



The project name must start with a letter. A minimum of 4 characters is allowed - (numbers, hyphen and underscore).



The required Geoscript must be saved in the folder *C:\ProgramData\LidarOs\geoscripts* in order to appear in the drop-down list.

Step 2 – Define Workflow

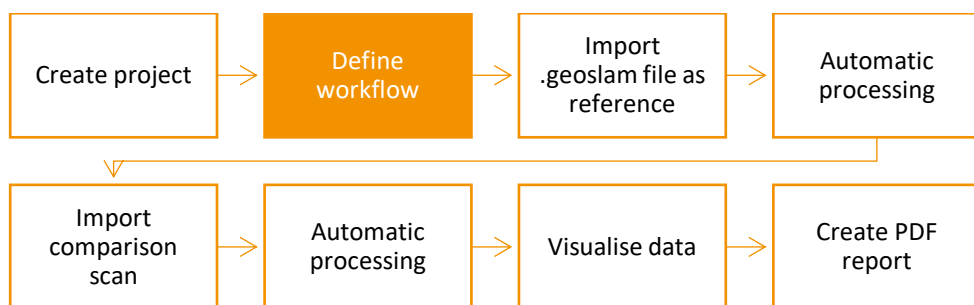


Figure 33 - Construction Progress workflow use: Step 2.

To define the workflow during project setup:

1. *Input* workflow during project setup (see step 1).

Or,

2. To change the current workflow for the project:

- a. *Select* -> **Options**.
- b. *Select* -> **3d-change-1.3.geoscript** from drop-down list.
- c. *Select* -> Close.
- d. Notification will show that the project workflow has been changed.



*The Advanced Settings Icon  allows the user to define the settings for the project. When using **3d-change-1.3.geoscript** make sure that this is set to **Once with all files**.*

Step 3 – Import .geoslam File as Reference

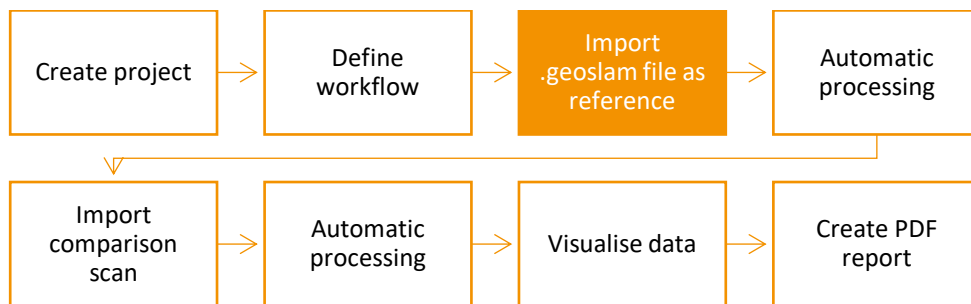


Figure 34 - Construction Progress workflow use: Step 3.

1. To import data:
 - a. *Select* -> **Import** icon.
 - b. *Select* -> **Add Files**.
 - c. *Browse* -> Raw data folder location.
 - d. *Select* -> user defined scan data file (ensure this is the first scan).
 - e. *Select* -> **Open** to continue.
 - f. *Select* -> **Import**.

The script will begin automatically, setting the imported scan as the reference scan. This will be indicated by the progress bar at the top of the Project Tree.

Step 4 – Automatic Processing

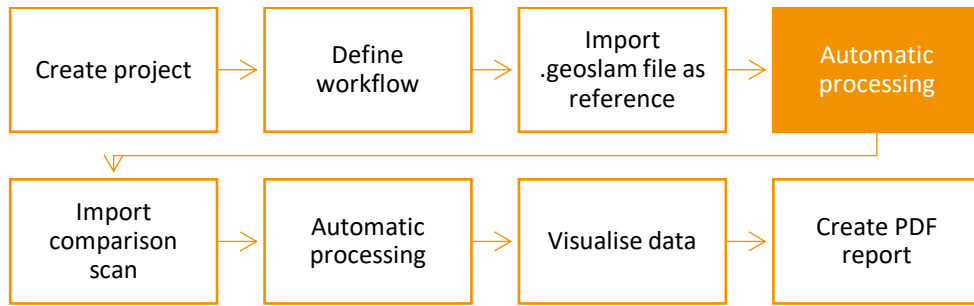


Figure 35 - Construction Progress workflow use: Step 4.

The defined Geoscript will run in the background during this step. The stages of the workflow script are defined below:

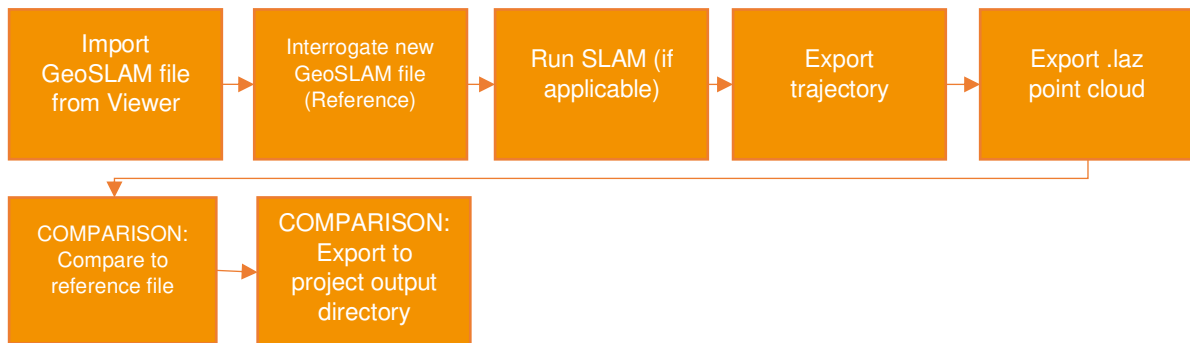


Figure 36 - Construction Progress workflow.

Step 5 – Import Comparison Scan

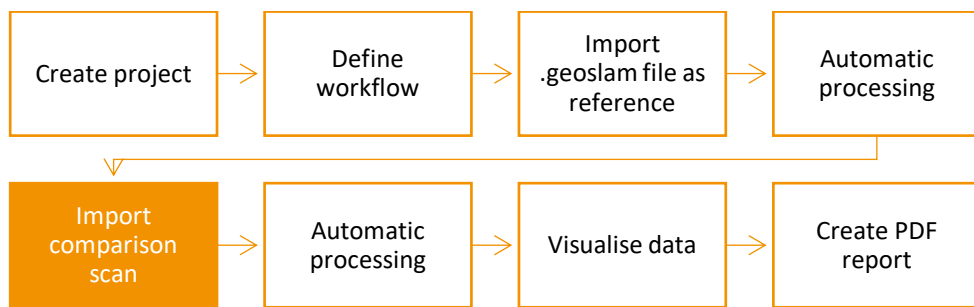


Figure 37 - Construction Progress workflow use: Step 5.

1. To import data:

- g. *Select* -> **Import** icon.
- h. *Select* -> **Add Files**.
- i. *Browse* -> Raw data folder location.
- j. *Select* -> user defined scan data file (ensure this is a later scan than the reference scan).
- k. *Select* -> **Open** to continue.
- l. *Select* -> **Import**.

Step 6 – Automatic Processing

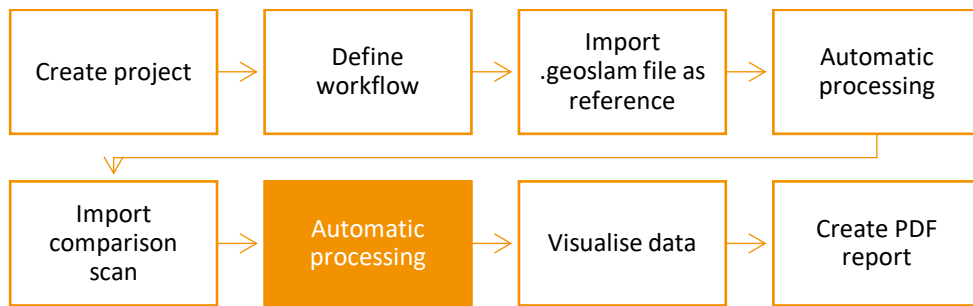


Figure 38 - Construction Progress workflow use: Step 6.

The defined Geoscript will run in the background during this step.

Step 7 – Visualise Data

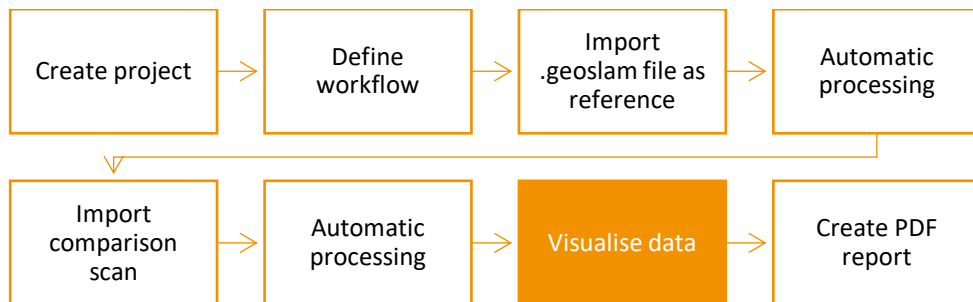


Figure 39 - Construction Progress workflow use: Step 7.

1. To visualise data once processing has completed:
 - a. *Select* -> **Reload** icon.
 - b. *Select* -> View LAZ file by double clicking the output LAZ file.

Step 8 – Create PDF report

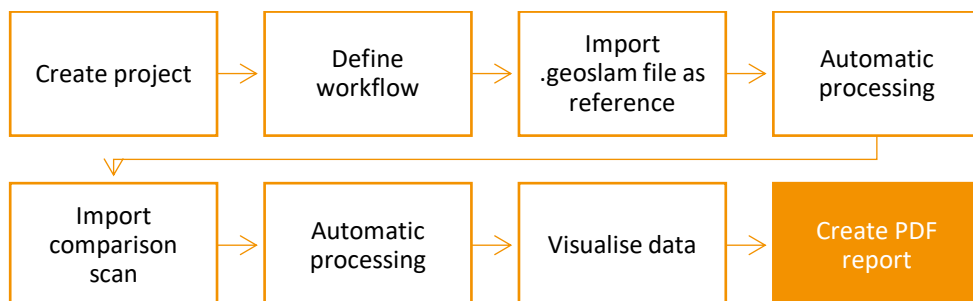



Figure 40 - Construction Progress workflow use: Step 8.

1. To create a PDF report:

- a) *Select* -> **Generate Report** icon 
- b) This will open the *Generate Report* dialog.
- c) *Input* -> Report name.
- d) *Select* -> Saved views to include in the report.
- e) *Input* -> Any project notes to be included.
- f) *Select* -> Generate report.

The report will be created and saved to *C:\ProgramData\LidarOs\projects\Floorplan\Reports*. The output will appear on the Project Tree list under **Reports**.

- g) *Double click* -> on the newly generated report.

This will open the PDF report using the default web browser. The report will display the notes at the top of the PDF and selected saved views and their titles on separate pages.

Optional – Add images/notes

If data has been captured using GeoSLAM Note (see Part 3 – **Program Interface**) Images and notes can be added to the scan during data import (step 3). The zipped image/notes file must be added at the same time as the scan data from which it was captured. The scan data must be added first so that it appears at the top of the import list (Figure 41).

1. To import images and scan data:
 - a. *Select* -> **Import** icon.
 - b. *Select* -> **Add Files**.
 - c. *Browse* -> Raw data folder location.
 - d. *Select* -> User defined scan data file.
 - e. *Select* -> **Open** to continue.
 - f. *Select* -> **Add Files**.
 - g. *Browse* -> Data folder location.
 - h. *Select* -> User defined zipped images file.
 - i. *Select* -> **Import**.

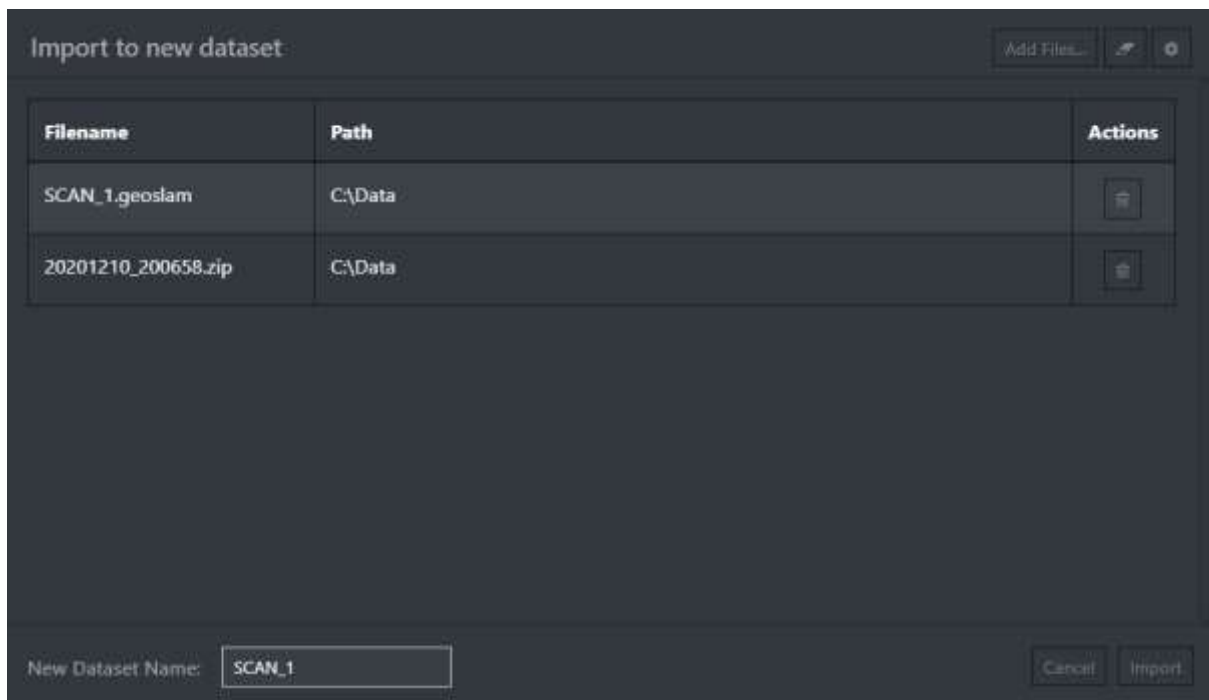


Figure 41 - Adding scan data and images to workflow.

Construction progress compared to the final CAD model

This workflow describes the steps necessary when creating a new project and running the **1.3 construction progress** Geoscript. This script will use the first scan imported as the reference scan, whilst all subsequent files will be considered the comparison scan. The script identifies reference points in each scan and uses these to register the comparison scan to the reference scan. Feature changes can then be identified and will be coloured to display the difference. These colours can be categorized as follows:

- Green = New feature added since last scan
- Blue = Old feature removed since last scan
- Black = Not enough point density in original scan for classification
- Grey = No noticeable change

During the data capture, a minimum of 3 reference points must be captured. This will allow the workflow to identify common points between scans and identify change. These points are captured when scanning, by placing any GeoSLAM scanner on a surface for a minimum of 10 seconds. Within all scans, these exact points must be recaptured exactly for registration to be successful.

The workflow will treat any initial imported GeoSLAM file as the dataset to which all other GeoSLAM files are registered to. Therefore, it is especially important for the initial scan to follow all best practices of scanning, and to note the exact location of any registered control

points for future use (or with use of the reference base). Please see section 5 – **Technical Reference** for more detail on the best practice for scanning with 3D change in mind.

Once a second scan has been imported and registered to the first, the two scans will be compared with changes appearing in different colours of the RGB category within the Connect Viewer. These colours scan be categorized as follows:

1. Green = New feature added since last scan
2. Blue = Old feature removed since last scan
3. Black = Not enough point density in original scan for classification
4. Grey = No noticeable change

In addition to the standard comparison outputs, a .laz will be produced in a separate folder within the output directory, with anything coloured in GREEN matching the CAD model as “Built”.

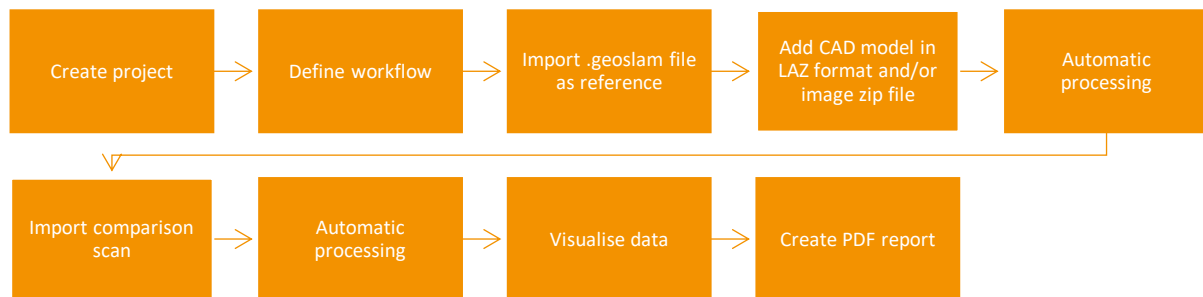


Figure 42 - Compare to CAD workflow.

Step 1 – Create New Project

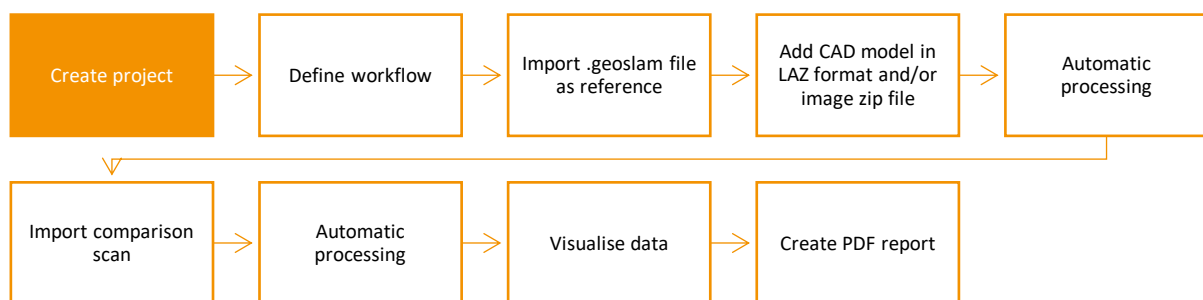


Figure 43 - Compare to CAD workflow: Step 1.

3. Open *GeoSLAM PointCloud Viewer* and sign in.
4. To create a new project, Select ->  -> **Projects -> Create New Project**.
 - a. At the *Add New Project* dialog:
 - i. *Input -> Project Name*.
 - ii. *Input -> Workflow 3d-change-1.3.geoscript*.
 - b. Select -> **Create Project** to continue.



The project name must start with a letter. A minimum of 4 characters is allowed - (numbers, hyphen and underscore).



The required Geoscript must be saved in the folder *C:\ProgramData\LidarOs\geoscripts* in order to appear in the drop-down list.

Step 2 – Define Workflow

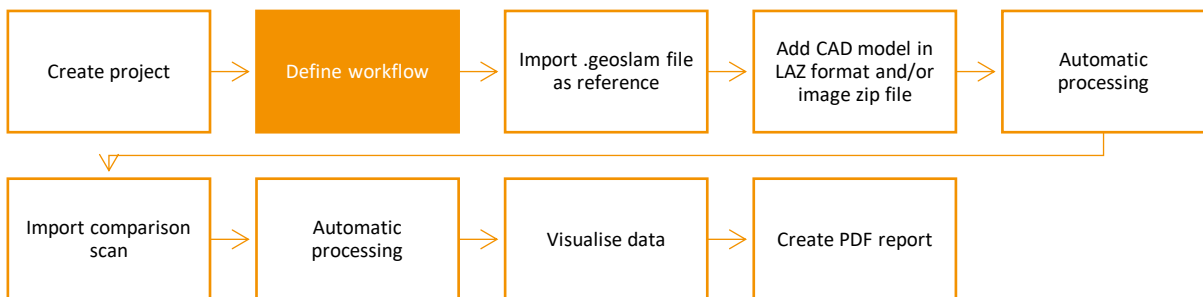


Figure 44 - Compare to CAD workflow: Step 2.


To define the workflow during project setup:

1. *Input* -> workflow during project setup (see step 1).

Or,

2. To change the current workflow for the project:
 - a) *Select* -> **Options**.
 - b) *Select* -> **3d-change-1.3.geoscript** from drop-down list.
 - c) *Select* -> Close.
 - d) Notification will show that the project workflow has been changed.



The Advanced Settings Icon  allows the user to define the settings for the project. When using **3d-change-1.3.geoscript** make sure that this is set to **Once with all files**.

Step 3 – Import .geoslam File as Reference

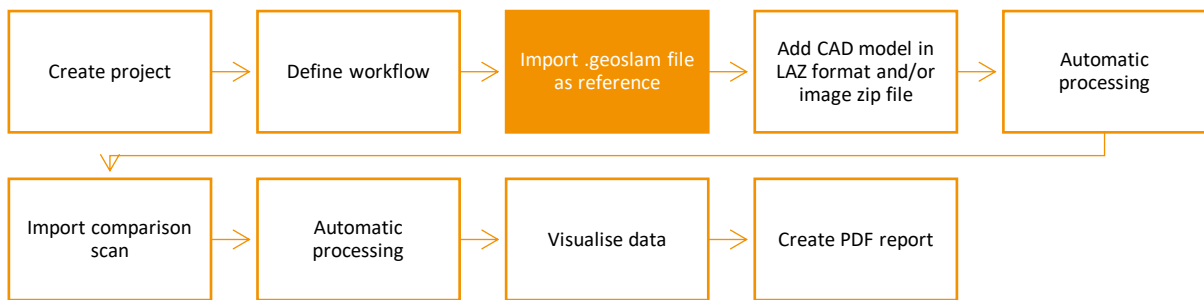


Figure 45 - Compare to CAD workflow: Step 3.

When importing the scan data, the .geoslam file must be added first so that it appears at the top of the import list.

To import data:

- a) *Select* -> **Import** icon.
- b) *Select* -> **Add Files**.
- c) *Browse* -> Raw data folder location.
- d) *Select* -> user defined scan data file (ensure this is the first scan).
- e) *Select* -> **Open** to continue.

Do not click Import. The Scan data will now appear at the top of the import list, allowing for the CAD model to be added in step 4.

Step 4 - Add CAD model and/or image zip file

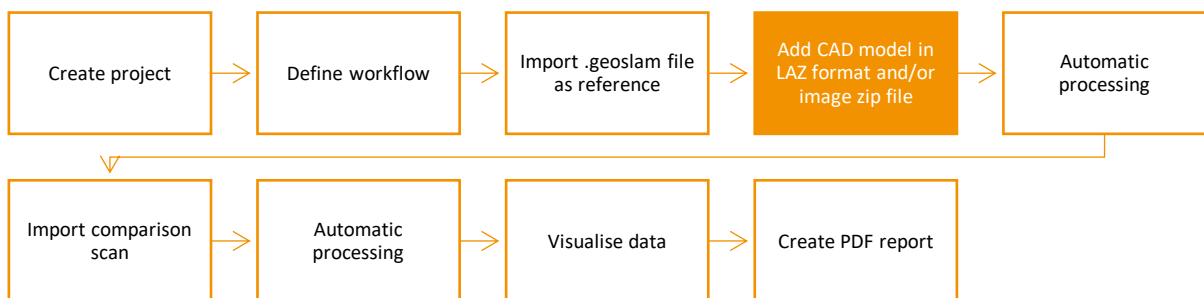


Figure 46 - Compare to CAD workflow: Step 4.

1. To import the CAD model and/or image zip file:
 - a) *Select* -> **Import** icon.
 - b) *Select* -> **Add Files**.
 - c) *Browse* -> Raw data folder location.
 - d) *Select* -> Registered CAD model in LAZ format.
 - e) *Select* -> **Open** to continue.
 - f) *Select* -> **Add Files**.
 - g) *Browse* -> data folder location.
 - h) *Select* -> user defined zipped images file.
 - i) *Select* -> **Import**.

The Import dialog box should look similar to Figure 47. The .geoslam file is read by the **3d-change-1.3.geoscript** first, and must therefore be the first dataset in the import list.

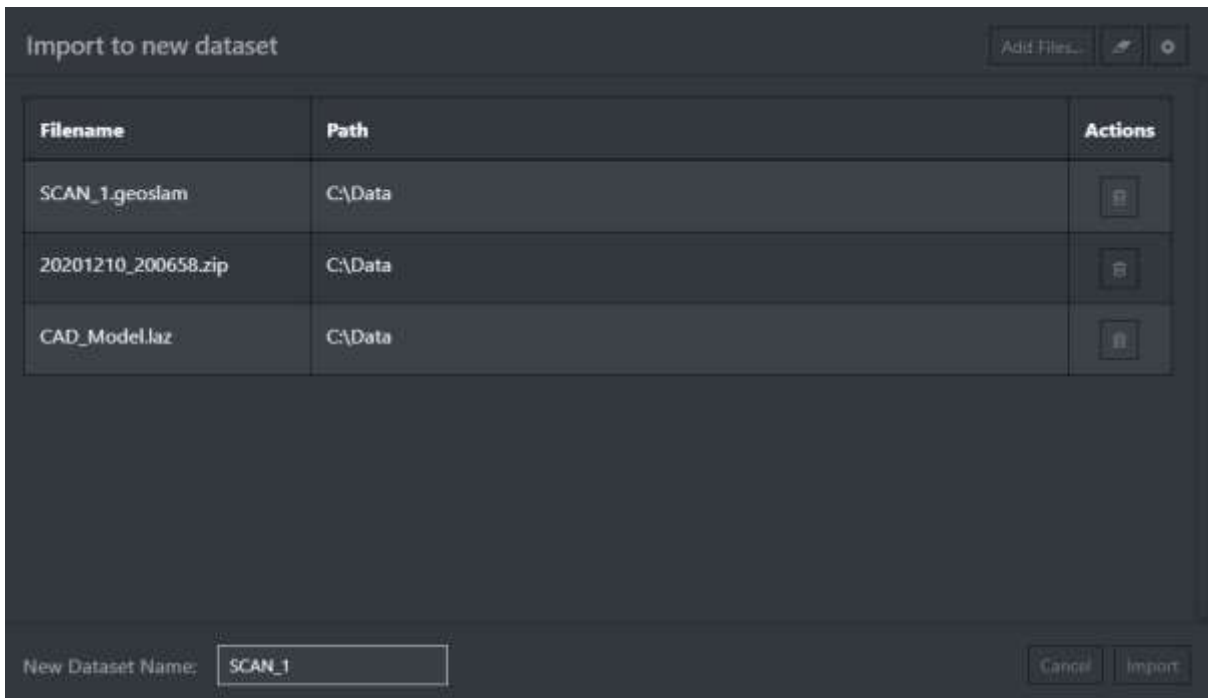


Figure 47 – Import data dialog box.

The script will begin automatically, setting the imported scan as the reference scan. This will be indicated by the progress bar at the top of the Project Tree.

Step 5 – Automatic Processing

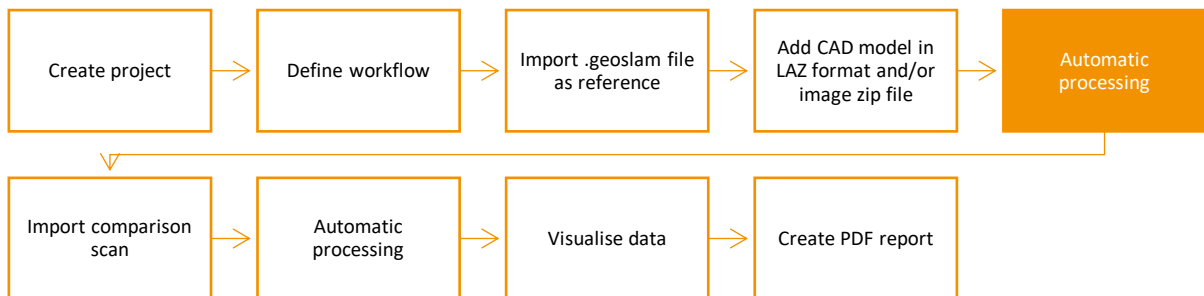


Figure 48 - Compare to CAD workflow: Step 5.

The defined Geoscript will run in the background during this step.

Step 6 – Import Comparison Scan

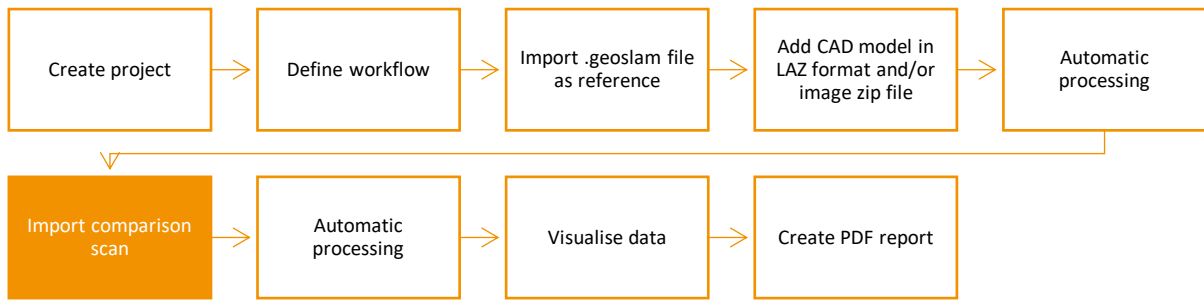


Figure 49 - Compare to CAD workflow: Step 6.

2. To import data:

- a) *Select* -> **Import** icon.
- b) *Select* -> **Add Files**.
- c) *Browse* -> Raw data folder location.
- d) *Select* -> user defined scan data file (ensure this is a later scan than the reference scan).
- e) *Select* -> **Open** to continue.
- f) *Select* -> **Import**.

Step 7 – Automatic Processing

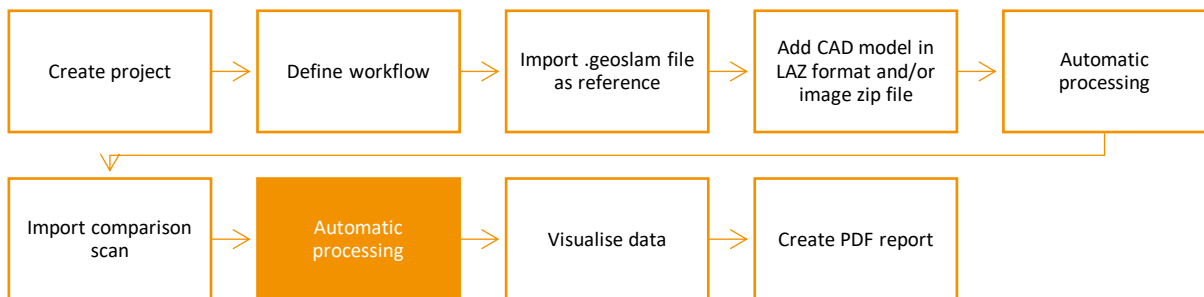


Figure 50 - Compare to CAD workflow: Step 7.

The defined Geoscript will run in the background during this step. The stages of the workflow script are defined below:

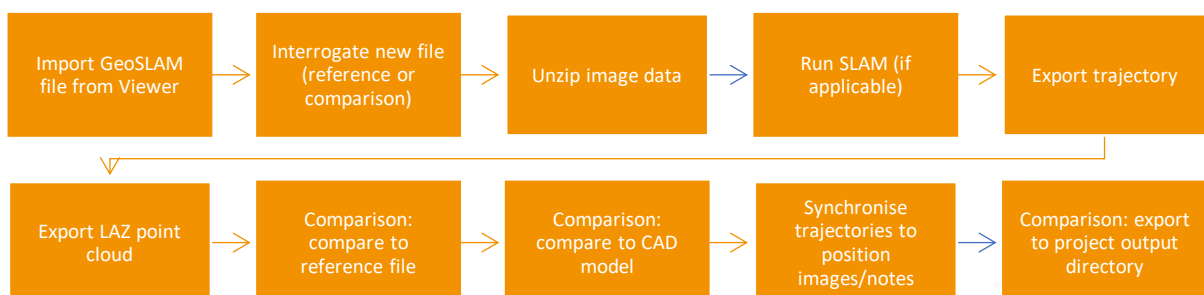


Figure 51 - Compare to CAD script steps.

Step 8 – Visualise Data

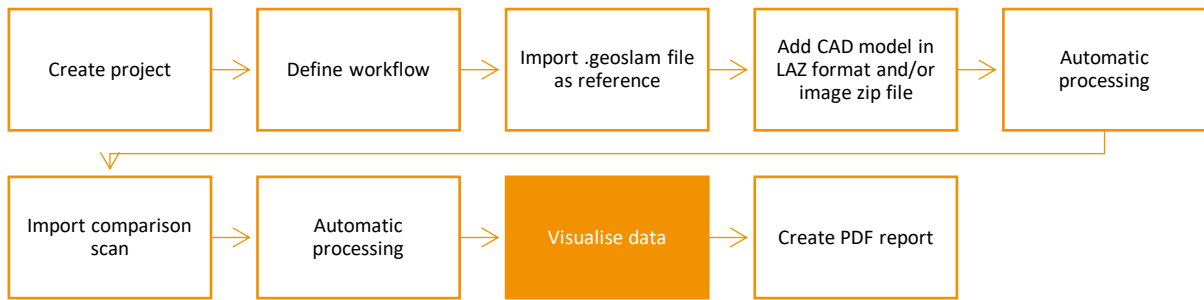


Figure 52 - Compare to CAD workflow: Step 8.

2. To visualise data once processing has completed:
 - c. *Select* -> **Reload** icon.
 - d. *Select* -> View LAZ file by double clicking the output LAZ file.

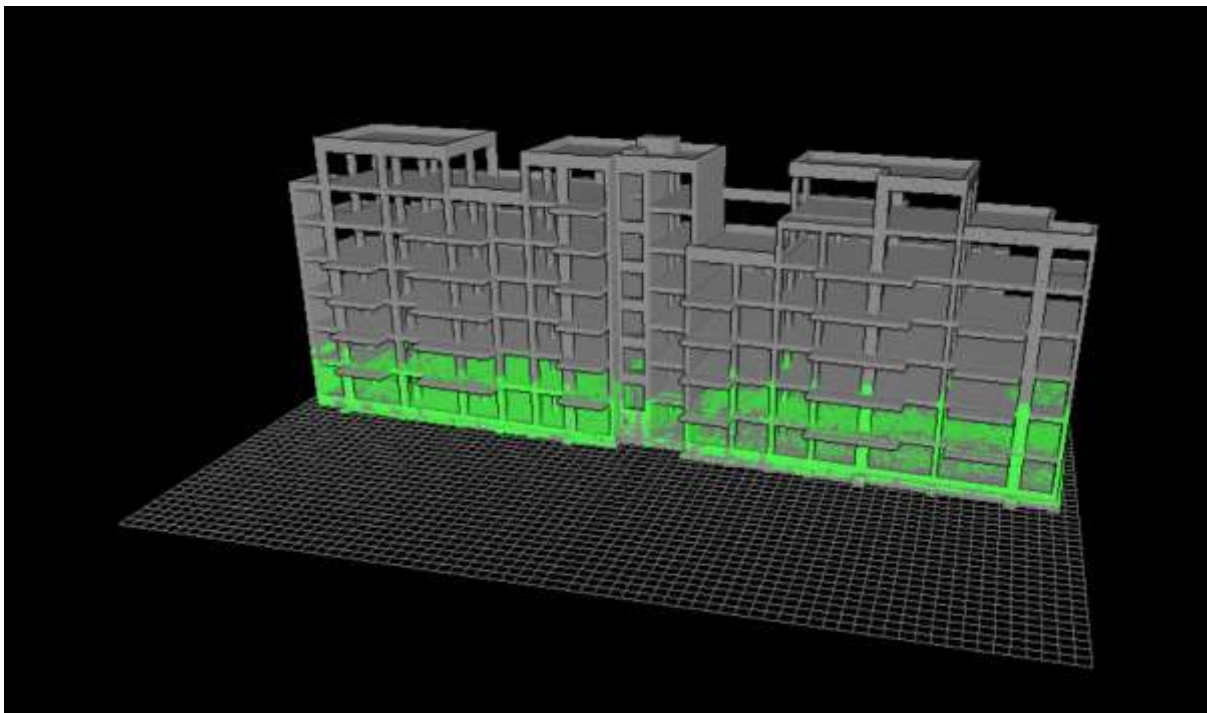


Figure 53 - An example of CAD reference LAZ.

Step 9 – Create PDF report

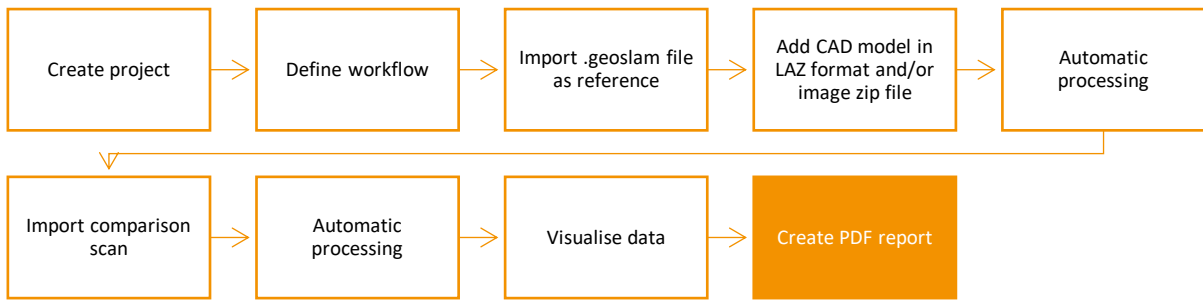



Figure 54 - Compare to CAD workflow: Step 9.

2. To create a PDF report:

- a) *Select* -> **Generate Report** icon .
- b) This will open the *Generate Report* dialog.
- c) *Input* -> Report name.
- d) *Select* -> Saved views to include in the report.
- e) *Input* -> Any project notes to be included.
- f) *Select* -> Generate report.

The report will be created and saved to *C:\ProgramData\LidarOs\projects\Floorplan\Reports*. The output will appear on the Project Tree list under **Reports**.

- g) *Double click* -> on the newly generated report.

This will open the PDF report using the default web browser. The report will display the notes at the top of the PDF and selected saved views and their titles on separate pages.

Geoslam Construction Progress software can process data from any of our mobile mapping product catalogue. This section will outline the best practices for scanning sites which is applicable to all of our ZEB family of mobile mapping products.

Prior to conducting any survey, the user should plan the data capture in order to ensure data is captured sufficiently. Planning will also highlight any potential problem areas e.g. environments with few features, doorway transitions and hazards. In order to achieve the best results when using GeoSLAM 3D change, ensure these guidelines have been followed correctly whilst capturing data.

Further tutorials and videos on how to capture data can be found on the GeoSLAM Youtube channel or GeoSLAM Academy.

Data capture – Scan

In order to register the reference scan to subsequent comparison scans and track the 3D change, it is important to start and end the scan in the same place. Throughout the scan there must also be at least 3 control points taken where the scanner has been placed and left static for 10 seconds. In each subsequent scans the control points must be in the same location to accurately match and register the scans. The use of base plates that are secured to an object that is static are recommended to ensure the operator returns to the same location each time.

Data capture – GeoSLAM Note App

Ensure there is some movement before the first image is taken to allow the software to recognise when there is a static period during image capture (minimum 5 meters between starting the scan and capturing the first image).

When capturing an image or note, remain static for at least 5 seconds. This will allow the software to accurately match the trajectory of the scanner and images during image capture periods.

There is no limit to the number of images that can be captured, however it is recommended to capture a minimum of 2 images per project (if images are required).

To begin data capture:

1. *Select* -> Start recording icon.
2. *Select* -> Capture icon.
3. *Take photo*.
4. *Select* -> tick to confirm image is correct.
5. *Add notes*.
6. *Save after each image captured*.
7. *Select* -> Stop recording icon to complete the image capture.

The Environment

The SLAM algorithm used to process the raw laser scan data into a 3D point cloud requires a variation in geometry and features within the scanning environment in order to correctly compute the position of the scanner in relation to its surroundings. For a feature to be significant the ratio of its size to its range must be approximately 1:10, e.g. at 5m range for a feature to be significant it must be >0.5m in size.

'Feature poor' environments include open spaces and smooth walled passageways. In smooth walled passageways there may be insufficient features in the direction of travel for the SLAM algorithm to determine forward motion. In feature poor environments we recommend the following:

1. Where possible, augment the environment with additional features. e.g. boxes in a corridor or a parked vehicle in an open field.
2. Ensure that whatever limited features are available are scanned repeatedly as you move through the environment by pointing the scanner in the direction of the feature. By doing so more measurement points are made of the feature increasing the likelihood that it will be used by the SLAM algorithm. This is particularly important when the feature is at long range (>10m). e.g. when scanning a smooth walled passageway where the only feature in the direction of travel is the end wall or door.
3. Avoid scanning moving objects (e.g. passing pedestrians or vehicles) as the SLAM algorithm may lock on to these objects as static features.

Loop Closure

The SLAM algorithm used to process the raw scan data into a point cloud uses a method analogous to the traverse technique used in survey practice, in that a previously known position is used to determine its current position. Not "closing the loop" can result in the compounding of any error introduced causing measure position to "drift". It is good survey practise to "close the loop" by re-surveying a known position so that the compounded error can be spread around the loop. As a minimum, it is required that the operator must start and end the survey in the same position to ensure at least one loop closure. However, it is recommended where possible that the operator closes the loop as often as possible in order to minimise error and improve the accuracy of the resulting point cloud. In general, it is better to do circular loops rather than "there and back" loops where the survey path simply doubles back on itself. This applies to horizontal and vertical loops, i.e. if possible enter and exit through different doors, move between floors via different stair wells. It is important to scan the closed loop regions carefully to ensure the key features are scanned from a similar perspective. It may be necessary to turn around if you return to a region from a different direction. This is particularly important in feature poor environments.

Transitioning Between Environments

Extra care must be taken when transitioning between environments, for example passing through a doorway or turning through a tight bend to avoid introducing errors. When transitioning between environments the local view may change abruptly and the SLAM algorithm may have difficulty placing the new environment relative to the previous environment. This may result in rooms either side of a doorway being slightly misaligned. Transition through doorways slowly and ensure that there is a period when the scanner can view features on both sides of the doorway (i.e. into both rooms). Try to open all doors before starting the survey. Avoid scanning doors as they are being opened. If necessary, face away from the door and open from behind then pass through the doorway backwards. Transition around tight bends slowly and ensure that there is a period when the scanner can view features on both sides of the bend. Take care when transitioning from an enclosed feature rich environment to an open feature poor environment, for example exiting a building. It may be necessary to turn and face the exit and the exterior of the building if no other features are within range. Avoid scanning any other moving objects (e.g. walking pedestrians) as you pass through a transition.

Walking Speed

It is recommended that data is captured at a slow walking pace to ensure good coverage and high-resolution data. If the forward movement is too fast there may not be enough repeat scans of features for the SLAM algorithm to be able to process the raw laser data into a point cloud.

Minimum And Maximum Range

Data within a small range value is not processed (by default) to eliminate data from the scanner operator being included in the final point cloud. Avoid close proximity to walls and ceilings. The maximum range of the scanner is 30m. This range will only be achieved in optimal conditions (indoors with good target reflectivity). The typical maximum range will be 15-20m in most conditions. It is recommended that the range is kept to less than 10m where possible to ensure good point density and to assist the SLAM algorithm.

Duration Of Scanning

For very large surveys the project should be broken down into more than one scan mission. This is to avoid very large file sizes as well as reduce any drift that might be created in the data. It is recommended that each survey is limited to 25 minutes. At walking pace, it is possible to cover approx. 2000m of survey distance.

Survey Areas With Restricted Or Difficult Access

The scanner head can remain stationary for short periods of time whilst the operator negotiates difficult access points (e.g. tight squeezes in cave systems). The scanner head can also be held in the hand and moved up and down to mimic the normal oscillating motion for short periods of time to assist transition through survey areas with restricted or difficult access.

Moving Objects In The Environment

In most case the SLAM algorithm is able to handle moving objects in the environment. In order to estimate the scanner motion the algorithm must assume a large proportion of the environment is static. However, in some feature poor environments where 3D structure is lacking in some dimensions, moving objects can have a greater impact on the solution. In particular, moving objects should be avoided in long tunnel-like environments (e.g. corridors), relatively open spaces and when transitioning through doorways. It is best practice not to have other people closely accompany the operator during the scan acquisition as they will be scanned throughout the map leaving streaks of data and potentially corrupting the solution in feature poor environments. If people are required to follow the operator they should ideally maintain a distance of 20m or more from the operator.